SEABIRD MONITORING

in

CHANNEL ISLANDS NATIONAL PARK

1990

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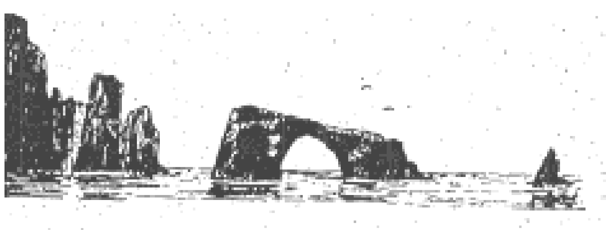

CHANNEL ISLANDS NATIONAL PARK NATURAL SCIENCE REPORT

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INTRODUCTION

There are two main reasons for monitoring seabirds and other natural resources at Channel Islands. The first is to detect changes in population dynamics over time; the second is to establish normal limits of change. This monitoring functions as an early warning to park managers of threats to resources or their environment.

The Seabird Monitoring Program began in 1985. The Seabird Monitoring Handbook (Lewis et al. 1988) details the monitoring protocol. We measure different parameters for each of the monitored species, depending on the potential disturbance to the colony and to other resources and whether or not colonies are accessible. Generally, we obtain some measure or estimate of nesting effort (breeding pairs, clutch size), nesting success (fledglings, growth rates), and phenology for the monitored species.

Five of the eight California Channel Islands are in the park -Anacapa, Santa Cruz, Santa Rosa, San Miguel, and Santa Barbara Islands (Fig. 1). We monitor six seabird species that nest on park islands (Table 1). These are two species of cormorant (Double-Crested and Pelagic), one pelican species (California Brown Pelican), one gull species (Western Gull), and two species of alcid (Cassin's Auklet and Xantus' Murrelet). California Brown Pelicans are an endangered species listed by the U.S. Fish and Wildlife Service (USFWS) and the state of California. The remaining five breeding species are not monitored by the park. These are Ashy, Black, and Leach's Storm-Petrels, Brandt's Cormorant, and Pigeon Guillemot.

Snowy Plovers (Charadrius alexandrinus nivosus) are also monitored as part of the seabird program; they nest and are monitored on San Miguel and Santa Rosa Islands. In response to a petition to list Snowy Plovers as threatened, USFWS ruled the listing was warranted but precluded at this time.

A major goal of the program this year was to develop a database management system to provide a means of archiving and analyzing field data in a consistent way. These results are presented in a separate section on data management. In addition, there is a section on monitoring recommendations which contains suggested changes in the monitoring protocol.

Summary of Results

Double-Crested Cormorant nest attempts on West Anacapa and Santa Barbara Islands were high at 340 and 267, respectively. Productivity was low at both colonies: 1. 51 :1: 0. 19 (mean ± standard deviation) on West Anacapa and 1.13 ± 0.34 on Santa Barbara Island. Estimated pairs breeding on Prince Island were 240 with 2.12 ± 0.09 fledglings per nest attempt.

Pelagic Cormorant nesting effort was the highest since monitoring of this species began in 1985, with 75 pair at Anacapa Island. Productivity was 1.45 :1-- 0.54 on East Anacapa and 1.62 ± 0.61 on West Anacapa.

California Brown Pelicans experienced one of the worst seasons in the last decade. Approximately 2,175 pelicans attempted nesting on West Anacapa Island, and over 75% of these abandoned their efforts midway through the season; productivity was the lowest since 1978, with 0.30 fledged young per nest attempt. On Santa Barbara Island, 225 pairs produced 3 fledged young.

For Western Gulls, although about 1,800 pair nested on Santa Barbara Island (the second highest record since 1972), clutch size (2.05 ±0.71), hatching success (0.59 ± **0.43), growth** rates (21.5 ± 3.8 g/day), and productivity (0.77 ± 0.79) were low. Gulls on East Anacapa experienced higher clutch sizes (2.79 ± 0.44) and hatching success (0.86 ± 0.25), but fledging success (0.46 ± 0.36) **and growth rates (119.4 ± 4.3** g/day) **were low; mean productivity was 1.** 18 ± 0.87.

Both reproductive effort and nesting success were low for Xantus' Murrelets on Santa Barbara Island. ' Of 109 potential sites, only 53% were used. Hatching success was low, although more eggs hatched at the Nature Trail site (0.54 ± 0.47) compared to the Cat

Canyon site (0.22 ± 0.37). Estimated productivity at Nature Trail and Cat Canyon were significantly different at 0. 79 ± 0.77 and 0.37 ± 0.62, respectively.

The low reproductive effort, low productivity, high rate of nest abandonment, and slow growth observed were likely the result of poor ocean productivity from unusually high sea surface temperatures in spring and summer.

Cassin's Auklet nest box occupancy was the highest since monitoring began, with 78% of 50 boxes used for nesting; productivity was not measured this year.

Snowy Plovers continued to decline on San Miguel Island beaches with only 42 breeding adults observed there. On Santa Rosa. Island, there were 101 breeding adults, of which 65 were in the Skunk Point area.

Table 1. Distribution of Seabirds Nesting in Channel Islands National Park (from Hunt et al. 1980).

FAMILY		SPECIES	ISLAND				
			ANI	SBI	SCI	SMI	SRI
				(see key below)			
Storm-Petrels Hydrobatidae		Ashy Storm-Petrel (*Oceanodroma homochroa*)		A	A	L	?
		Black Storm-Petrel (*O. melania*)		L	?		
		Leach's Storm-Petrel (*O. leucorhoa*)		?	?	L	?
Cormorants Phalacrocoracidae		Brandt's Cormorant (*Phalacrocorax penicillatus*)	O	A	A	L	A
	●	Double-crested Cormorant (*P. auritus*)	A	A		L	
	●	Pelagic Cormorant (*P. pelagicus*)	A	O	A	L	A
Pelicans Pelecanidae	●	California Brown Pelican (*Pelecanus occidentalis californicus*)	L	A	O	O	
Gulls Laridae	●	Western Gull (*Larus occidentalis*)	L	A	A	A	A
Alcids Alcidae	●	Cassin's Auklet (*Ptychoramphus aleuticus*)		A	A	L	
		Pigeon Guillemot (*Cepphus columba*)	A	A	A	L	A
	●	Xantus' Murrelet (*Synthliboramphus hypoleuca*)	A	L	A	A	

Key: ANI = Anacapa Is. SBI = Santa Barbara Is. including Sutil Is. SCI = Santa Cruz Is. including Gull Is. and Scorpion Rock

SMI = San Miguel Is. including Prince Is. SRI = Santa Rosa Is.

Distribution:
A = Active Colony
O = Occasional Colony
L = Largest Colony
? = Probably Present
● = Monitored Species

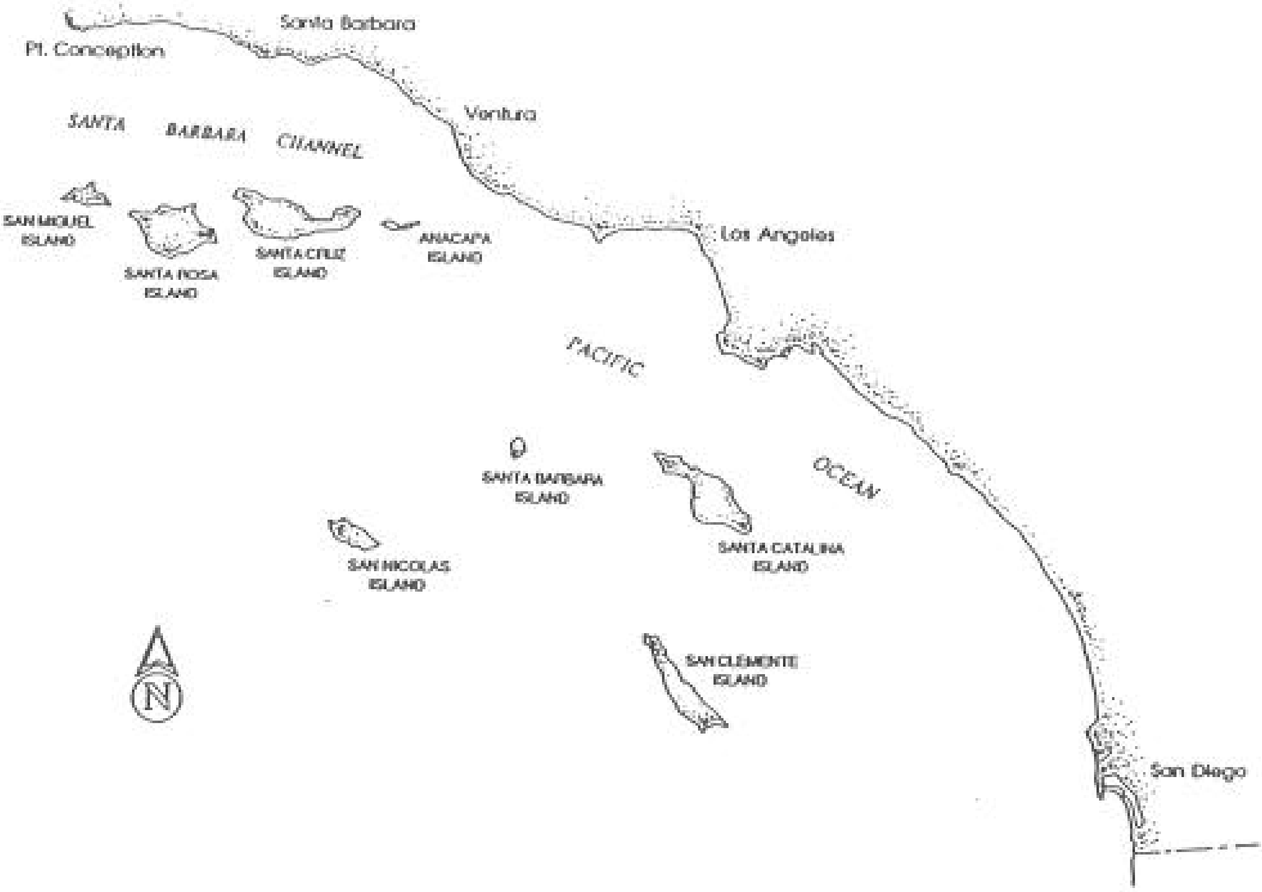


Figure 1. The eight California Channel Islands and adjacent mainland. (Anacapa, Santa Cruz, Santa Rosa, San Miguel, and Santa Barbara Islands are part of Channel Islands National Park).

DOUBLE-CRESTED CORMORANT

Double-Crested Cormorants (Phalacrocorax auritus) are a widespread breeding species, with coastal colonies from Alaska to Baja California. Once very common breeders in the Channel Islands, they declined markedly to only a few pair at some sites by the early 1970's. Factors that most likely contributed to this decrease were human disturbance and reproductive failures from DDT-related eggshell thinning (Gress et al. 1973). Since the late 1970's, Double-Crested Cormorants have begun to rebound from these declines.

In the Channel Islands, Double-Crested Cormorants build nests on vertical cliff faces, on steep, rocky slopes, and on bluff edges. We monitor phenology and number of nesting pairs on West Anacapa, Santa Barbara (including Sutil), and Prince Islands, and estimate productivity from samples at these colonies (see monitoring handbook, pgs. 2230).

The 1990 breeding season was characterized by a large effort accompanied by moderate rates of nest abandonment and moderate to low productivity. Productivity was lowest at Santa Barbara Island and highest at Prince.

Phenology and Nest Locations

Nesting began earlier on West Anacapa (late March) than on Santa Barbara Island (early April) (Table 2); however, at both colonies there were two fairly discreet breeding efforts. On Anacapa, nesting began later in areas west of Oak Canyon (99 nests) than at the more eastern sites (see Fig. 2). On Santa Barbara Island, there was a late breeding effort (35 nests) primarily in the North Peak area (see Fig. 3). Thus, egg **laying extended into June on both islands** (Table 2). Hatching started in late April and continued through early July on Anacapa, and on Santa Barbara, hatching began in early May and continued through late July (Table 2). Fledging was estimated as complete on Anacapa by the end of August and on Santa Barbara by late September.

On Prince Island, we did one complete survey in early May, at which time small chicks were present in some nests. This information together with known incubation times of 25-30 days, indicates nesting on Prince began in mid to late March.

On the north side of West Anacapa, nesting sites were spread between the Amphitheater in the east to the Sea Lion Cove area on the west end (Fig. 2). The largest subcolony was at the Camel Ridge sites (91 nests), just west of the Amphitheater. Continuing westward, the next discreet nesting areas were Summit Canyon (56 nests) and Oak Canyon and associated bluffs (61 nests). The remaining subcolonies were located at North Bluff (67 nests), Grottos blufftop (26 nests), and the Sea Lion Cove area (28). These areas are traditional nesting sites for Double-Crested Cormorants.

On Santa Barbara Island, Double-Crested Cormorants nested in the North Peak area (175 nests), West Cliffs (40 nests), the top of Sutil Island (50 nests), and Shag Rock (2 nests), all historical breeding sites (Fig. 3).

Table 2. Pheonology of Double-Crested Cormorants on West Anacapa and Santa Barbara Islands, 1990.

	West Anacapa	Santa Barbara
Egg Laying		
Begin	L-March	E-April
End	L-May/E-June	L-June
Hatching		
Begin	L-April	E-May
Peak	M-May	M/L-May
End	L-June/E-July	L-July
[1]Fledging		
Begin	M/L-June	M/L-June
End	M/L-Aug	M/L-Sept

[1] Estimated, based on 7-8 week fledging period.

E = Early, Days 1-10
M = Middle, Days 11-20
L = Late, Days 21-31

On Prince Island, most nesting occurred in previously used areas, atop the cactus patch on the east end (10 nests) and in the rocks on the southeast side (140 nests) (Fig 4). There was also a new subcolony, consisting of 90 nests, not noted in recent years; these nests were in the rocks on the northeast side above the auklet grid.

Reproduction

West Anacapa

Three hundred forty (340) pairs attempted to nest on West Anacapa. The rate of nest abandonment through mid June was 19.1%. From 5 sample areas (131 nests), we estimated 512 chicks fledged. This is an average of the minimum number of chicks, assuming the sample rate of nest abandonment, and the maximum number of chicks, assuming no abandonment after the last survey (see Table 3). Colonywide productivity was estimated at 1.51 ± 0.19 (Mean ± s.d.).

Nest attempts on West Anacapa **have increased steadily since the late 1970's, from 15 in 1977** to 340 this year (Fig. 5). Productivity has followed a similar trend, varying between 0.5-1.5 for the period 1977 to 1983 and between 1. 5-2.5 for the more recent years, 1984-1990.

Santa Barbara

We observed 267 nest attempts for doublecrests on Santa Barbara Island, including Sutil Island and Shag Rock (see Table 4). Nest abandonment was high at 30.8%. Colonywide, an estimated 301 chicks fledged, and productivity was 1.13 :t 0.34.

Reproductive effort on Santa Barbara Island for the past six years has increased (Fig. 6). Nest attempts have gone from 60 in 1985 to the present 267. Productivity remained between 1.5 and 2.0 for the period 1985 through 1988; 1990 was the poorest year for productivity since 1985.

Prince Island

Monitoring Double-Crested Cormorants on Prince Island has proven more difficult, and therefore less accurate, than on the other islands (see section on Monitoring Recommendations). Therefore, these data, as for the previous five years of monitoring, are general estimates.

We estimated nest abandonment, fledglings, and productivity from two sample areas containing a total of 90 nests. A post-season mortality count of dead chicks in this area allowed some refinement of the chick count. These data are presented in Table 5.

Total pairs breeding was estimated at 240. Estimated success, colonywide, was 502 chicks fledged and 2.12 ± 0.09 fledglings per attempt. Nest abandonment was low (8.1 %) compared to that on the Anacapa and Santa Barbara Island colonies.

In 1986, pairs were estimated at 50, with about 100 chicks fledged. Thus, the general pattern of increased nesting in Double-Crested Cormorants observed at other park islands, is also **evident at Prince** Island.

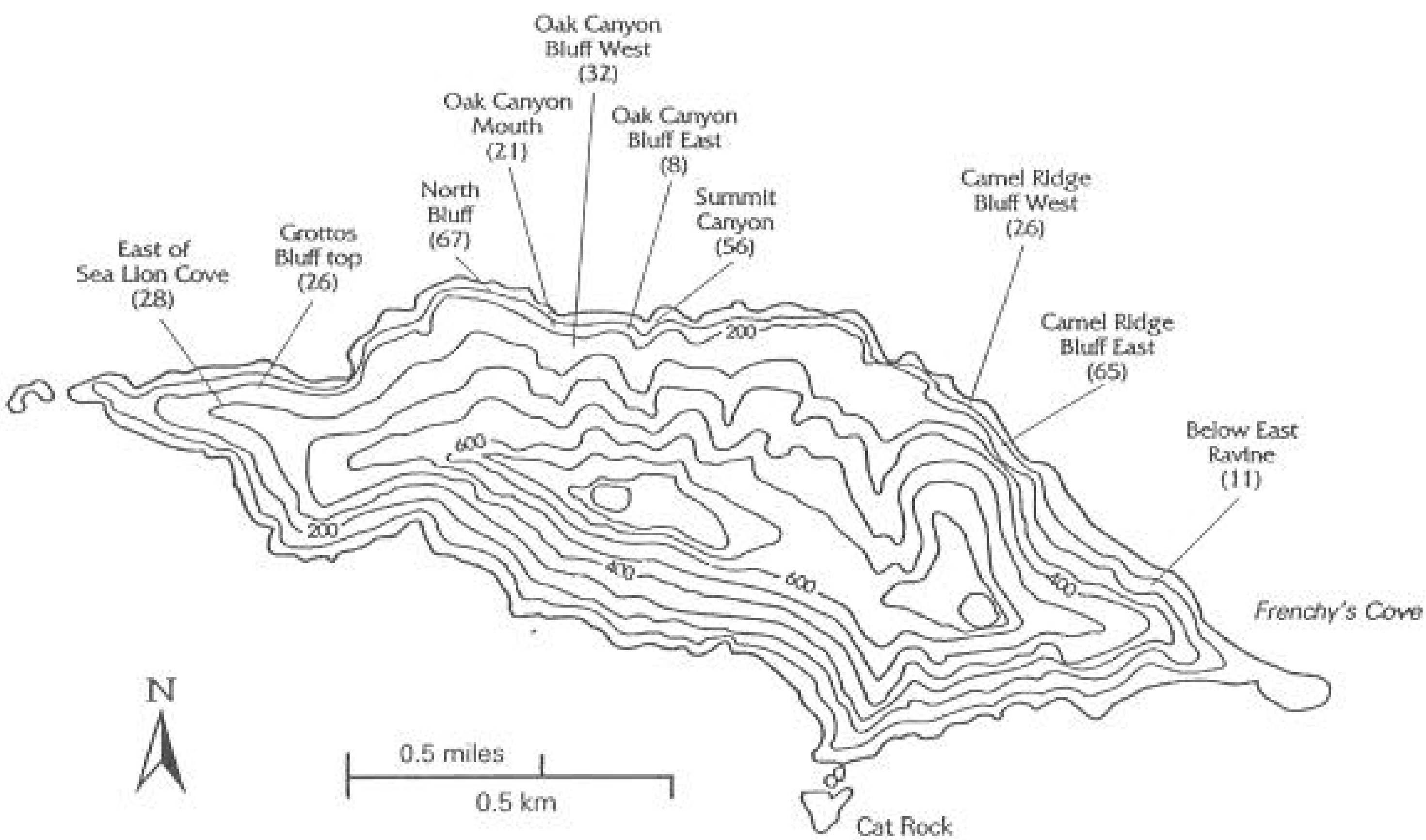


Figure 2. Nesting locations of Double-Crested Cormorants on West Anacapa Island, 1990 (number of nests in each area is in parentheses).

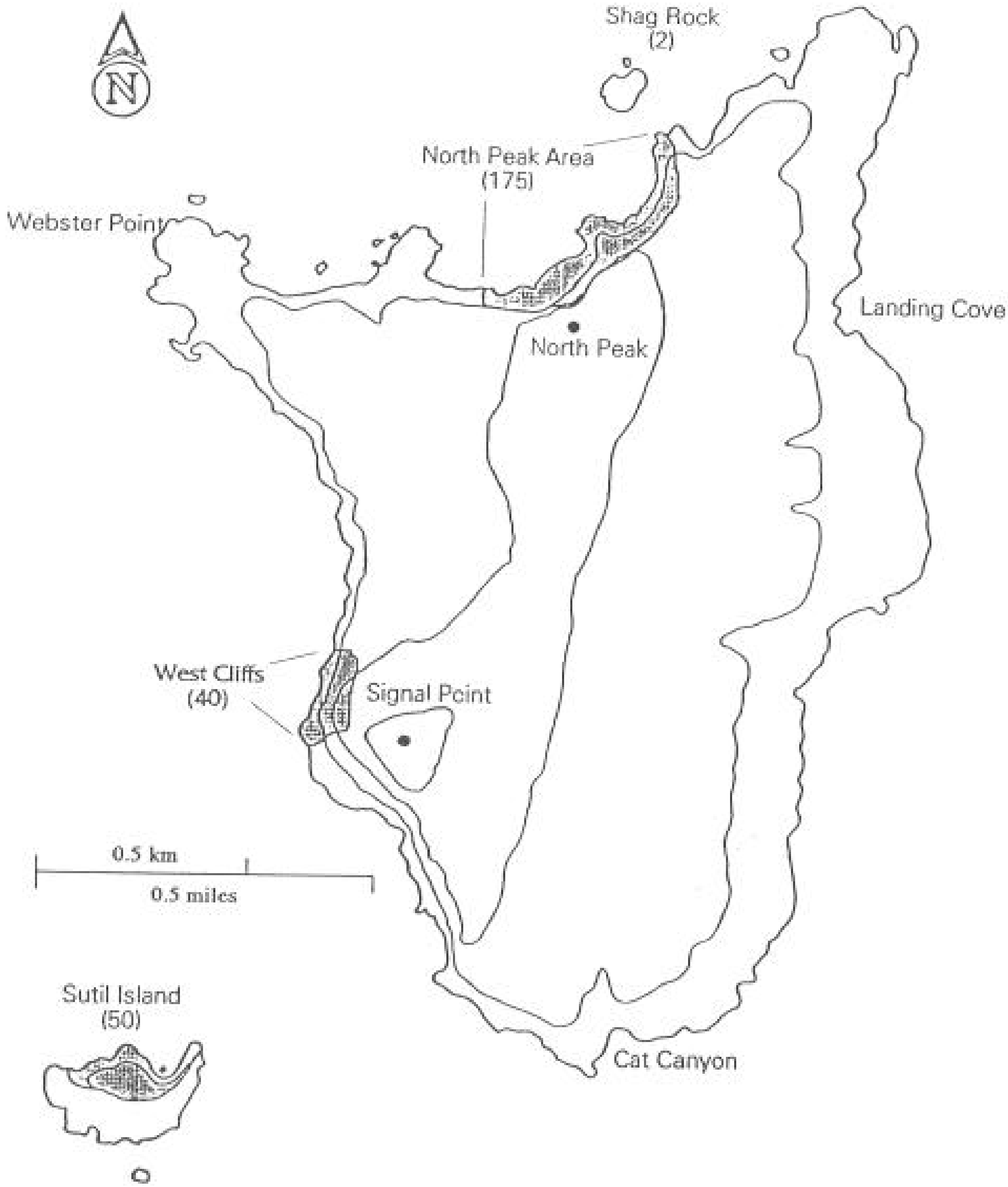


Figure 3. Nesting locations of Double-Crested Cormorants on Santa Barbara Island, 1990 (shaded areas; number of nests in each area is in parentheses).

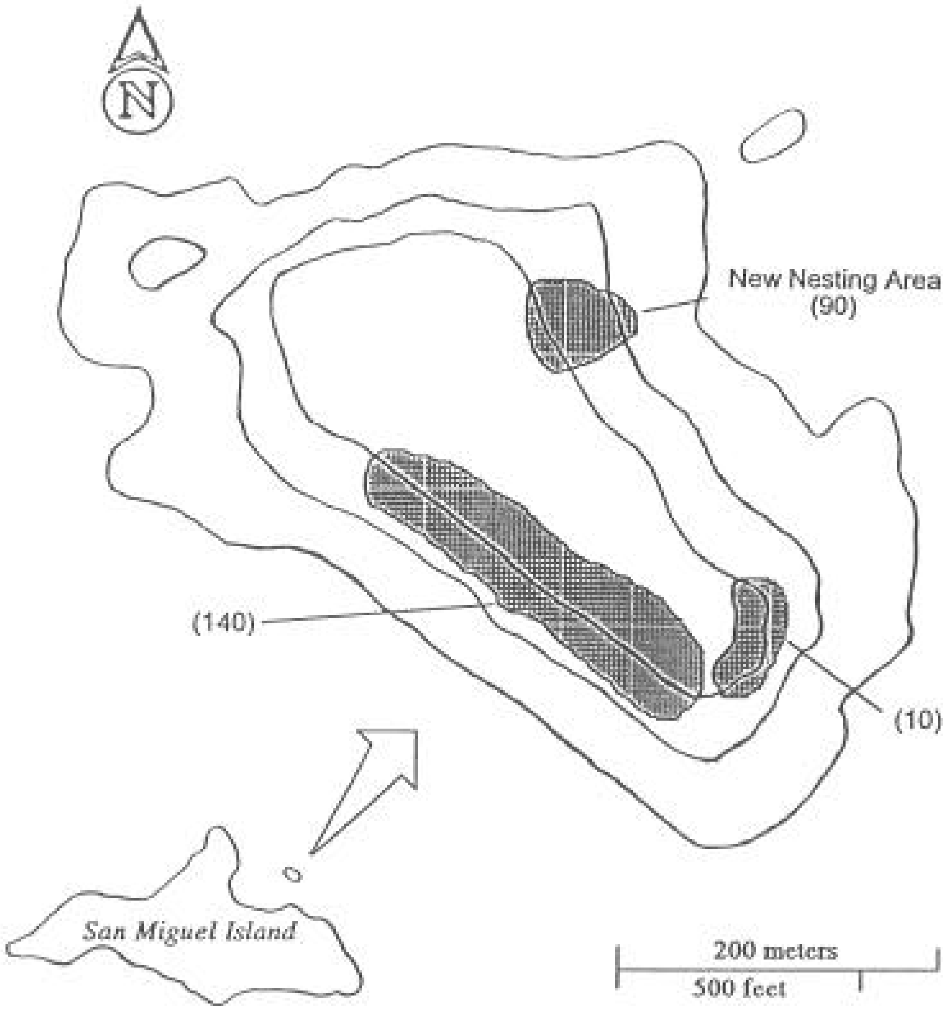


Figure 4. Nesting locations of Double-Crested Cormorants on Prince Island, 1990 (shaded areas; number of nests in each area is in parentheses).

Table 3. Reproduction in Double-Crested Cormorants on West Anacapa Island, 1990.

	Total in Colony	[1]Total in Sample	Mean ± s.d.
Nests Attempted			
With countable chicks		49	9.80 ± 8.35
With incubating or brooding adult	267	60	12.00 ± 12.35
Abandoned		22	4.40 ± 4.78
Total	340	131	
[2]Fledglings	(512)	91	8.27 ± 4.78
[3]Productivity			
Sample			1.82 ± 0.17
Colonywide			(1.51 ± 0.19)

( )denotes estimated values.

[1] n = 5 subcolony areas.

[2] Fledglings

Colonywide = Average of minimum (assuming sample abandonment rate) and maximum values (assuming no later abandonment):

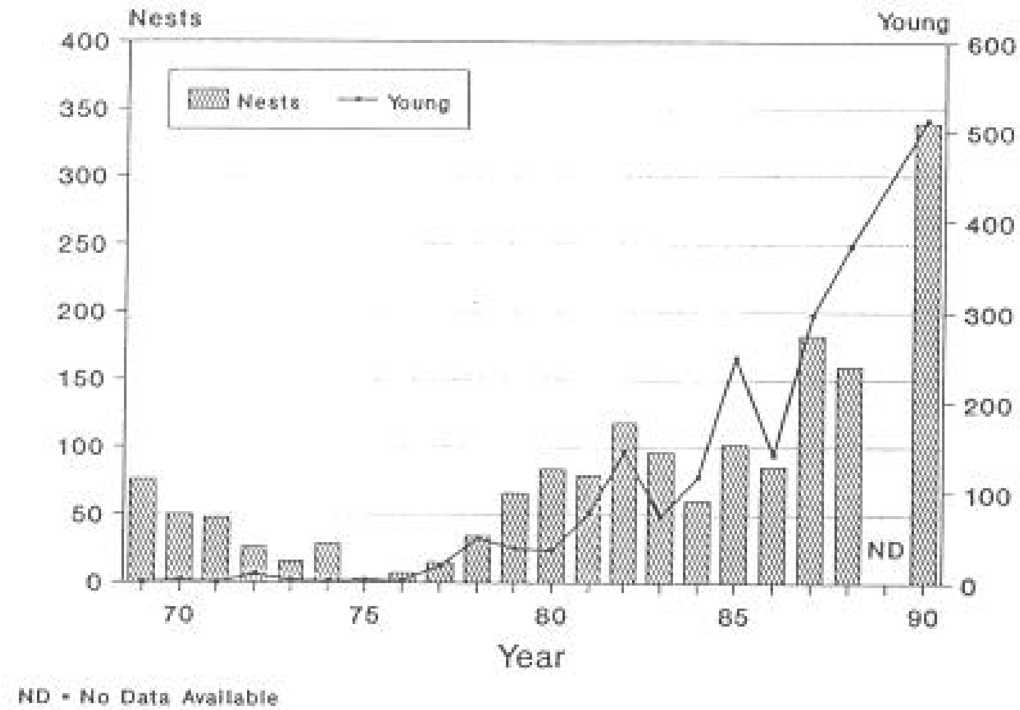
Minimum = Sample productivity X total nests with brooding or incubating adults - late abandoned nests + chicks fledged in sample.

Maximum = Sample productivity X total nests with brooding or incubating adults + chicks fledged in sample.

[3] Productivity

Sample = Sample chicks fledged/sample nests with chicks.

Colonywide = Sample productivity X sample nests with brooding or incubating adults + chicks fledged in sample/nests in sample.



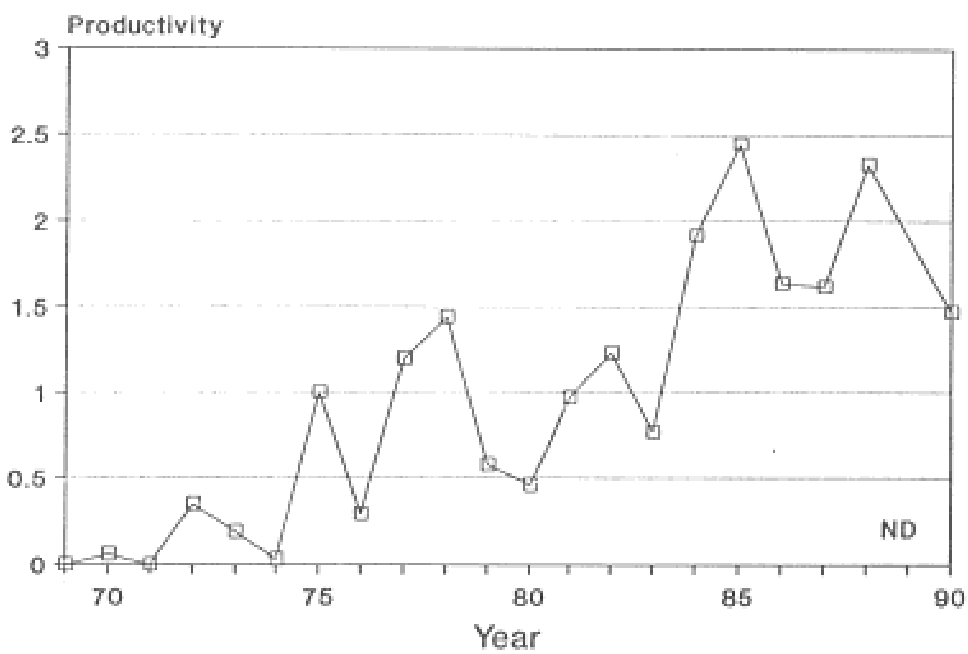


Figure 5. Reproduction in Double-Crested Cormorants on West Anacapa Island 1969-1990 (see Appendix A for data sources).

Table 4. Reproduction in Double-Crested Cormorants on Santa Barbara Island, 1990.

	Total in Colony	[1]Total in Sample	Mean ± s.d.
Nests Attempted			
With countable chicks		22	2.44 ± 1.88
With incubating or brooding adult	194	104	11.89 ± 9.08
[1]Abandoned		46	5.11 ± 4.31
Total	267	175	
[2]Fledglings	(301)	33	3.67 ± 2.78
[3]Productivity			
Sample			1.51 ± 0.33
Colonywide			(1.13 ± 0.34)

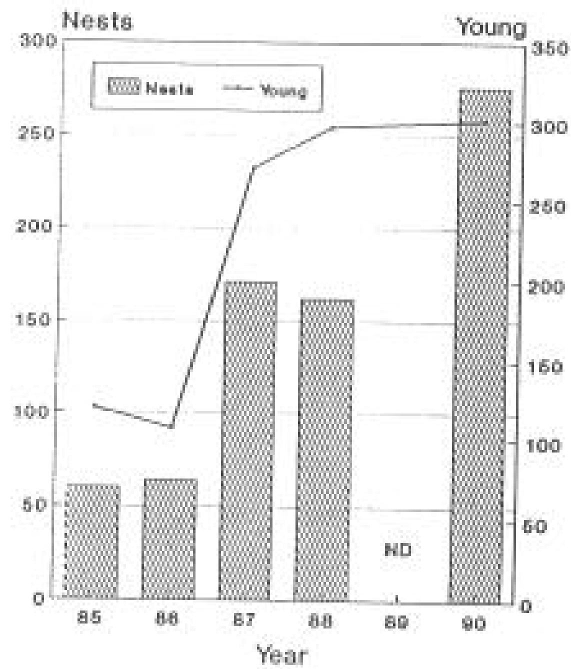
( )denotes estimated values.

[1] n = 8 subcolony areas.

[2] Fledglings
Colonywide = Total nest attempts X colonywide productivity. (Assumes no nest abandonment after survey dates).

[3] Productivity
Sample = Sample chicks fledged/sample nests with chicks.

Colonywide = Sample productivity X sample nests with brooding or incubating adults + chicks fledged in sample/total nests in sample.



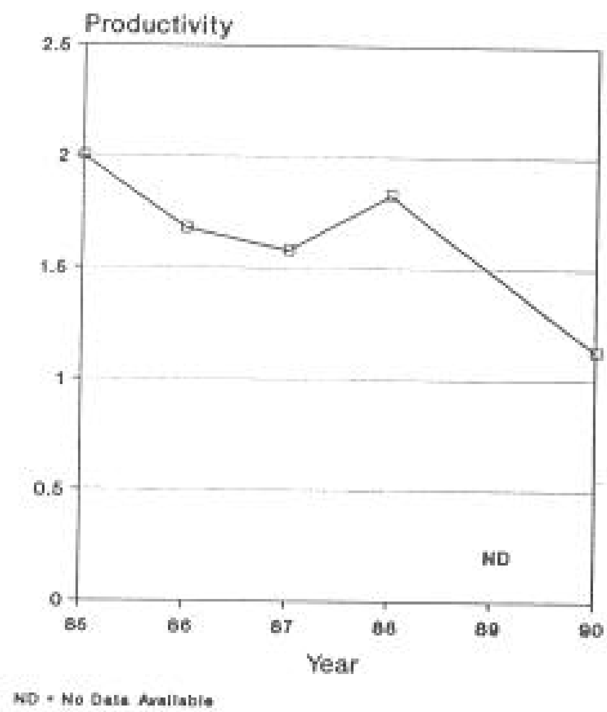


Figure 6. Reproduction in Double-Crested Cormorants on Santa Barbara Island, 1985-1990 (see Appendix A for data sources).

Table 5. Reproduction in Double-Crested Cormorants on Prince Island, 1990.

	Total in Colony	[1]Total in Sample	Mean ± s.d.
Nests Attempted			
With countable chicks		25	12.5 ± 2.1
With incubating or brooding adult	209	59	8.4 ± 15.2
Abandoned		6	3.0 ± 4.2
Total	240	90	
[2]Fledglings	(502)	56	28.0 ± 5.7
[3]Productivity			
Sample			2.23 ± 0.07
Colonywide			(2.12 ± 0.09)

( )denotes estimated values.

[1] n = 2 subcolony areas.

[2] Fledglings
Colonywide = Total nest attempts X colonywide productivity. (Assumes no nest abandonment after survey date).

[3] Productivity
Sample = Sample chicks fledged/sample nests with chicks.

Colonywide = Sample productivity X sample nests with brooding or incubating adults + chicks fledged in sample/total nests in sample.

PELAGIC CORMORANT

Pelagic Cormorants (Phalacrocorax oelaoicus) nest from Japan through Alaska, all along the North American coast south to northern Baja California. Their present breeding range reaches its southern limit in the Channel Islands, although nesting here has been intermittent. Accounts from the early 1900's report Pelagic Cormorants breeding regularly at San Miguel Island and sporadically at Anacapa and Santa Barbara Islands. Pelagics began nesting again on Anacapa Island in 1984, from where they had been absent for at least the previous 16 years.

Pelagic Cormorants nest on steep cliffs on the mainland generally in small, scattered groups rather than in large colonies. Nesting habitat in the park includes small ledges and rock outcrops on sheer cliffs and in, or near entrances to, sea caves.

In 1985, the park added Pelagic Cormorants to the monitoring program. We record phenology, and total number of nesting pairs, and estimate productivity from samples on East, Middle, and West Anacapa Islands.

Phenology and Nest Locations

Pelagic Cormorants began laying eggs in late March. Most clutches were complete by late April, when the first chicks began hatching. Large chicks near fledging were common at nest sites in mid to late June.

On West Anacapa, caves and ' grottos along the north shore provide suitable nesting habitat, and nests are often near the water; the largest subcolony (14 nests) was in Box Canyon Cave and adjacent ledges (Fig. 7). On East Anacapa, small ledges on cliff faces are more common sites for nests; the largest nest grouping there (14 nests) was in Garbage Cove. Middle Anacapa appears to harbor suitable nesting sites but remains largely unused.

Reproduction

A total of 75 pair attempted to nest on Anacapa Island (East, 26; Middle, 4; West, 45) (Table 6). The nests on Middle Anacapa were the first observed there for at least the past 20 years. Pelagic Cormorants breeding on Anacapa Island have increased steadily in recent years, from 13 nests in 1984 to 75 nests in 1990 (Fig. 8).

An estimated 117 chicks fledged from East, Middle and West Anacapa (Table 6). Productivity (fledglings per nest attempt) on East Anacapa (1.45 ± 0.54) was lower than it was on West Anacapa (1.62 ± 0.61), although this difference was not statistically significant ($t=0.49$, $p=0.64$). Nesting success on Middle **Anacapa was not determined.**

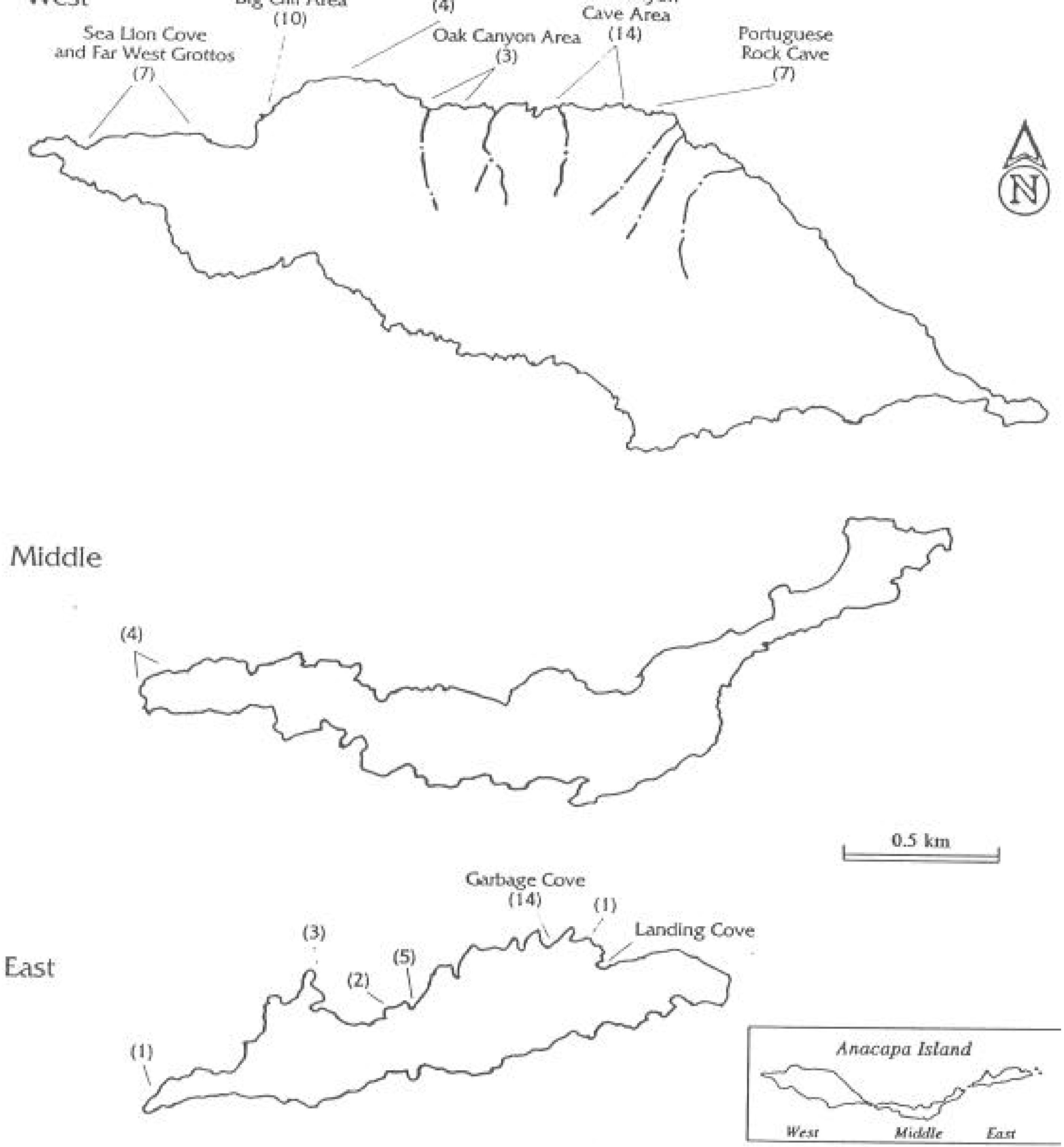


Figure 7. Nesting locations of Pelagic Cormorants on East, Middle, and West

Table 6. Reproduction in Pelagic Cormorants on Anacapa Island, 1990.

	EAST Total	EAST [1]Sample	EAST Mean ± s.d.	WEST Total	WEST [1]Sample	WEST Mean ± s.d.	MIDDLE Total	MIDDLE [1]Sample	TOTAL
Nests Attempted									
With countable chicks	12	12	2.40 ± 2.70	23	21	1.92 ± 1.44	—	—	
With incubating or brooding adults	12	12	2.40 ± 2.79	18	15	1.50 ± 1.73	4	4	
Abandoned	2	2		4	4				
Total	26	26		45	40		4	4	75
[2]Fledglings	(38)	18		(73)	39		Not determined		[3](117)
[4]Productivity									
Sample			1.52 ± 0.41			1.74 ± 0.52	Not determined		
Colonywide			(1.45 ± 0.54)			(1.62 ± 0.61)			(1.53)

( ) denotes estimated values.

[1] Subcolony areas: n=5, East Anacapa; n=12, West Anacapa; n=1, Middle Anacapa.

[2] Fledglings, colonywide = Total nest attempts x colonywide productivity.

[3] Includes 6 chicks from Middle Anacapa projected from sample productivity of 1.6 from East and West Anacapa.

[4] Productivity
Sample = sample chicks fledged/sample nests with chicks
Colonywide = sample productivity x sample nests with incubating or brooding adults + chicks fledged in sample/nest attempts in sample.

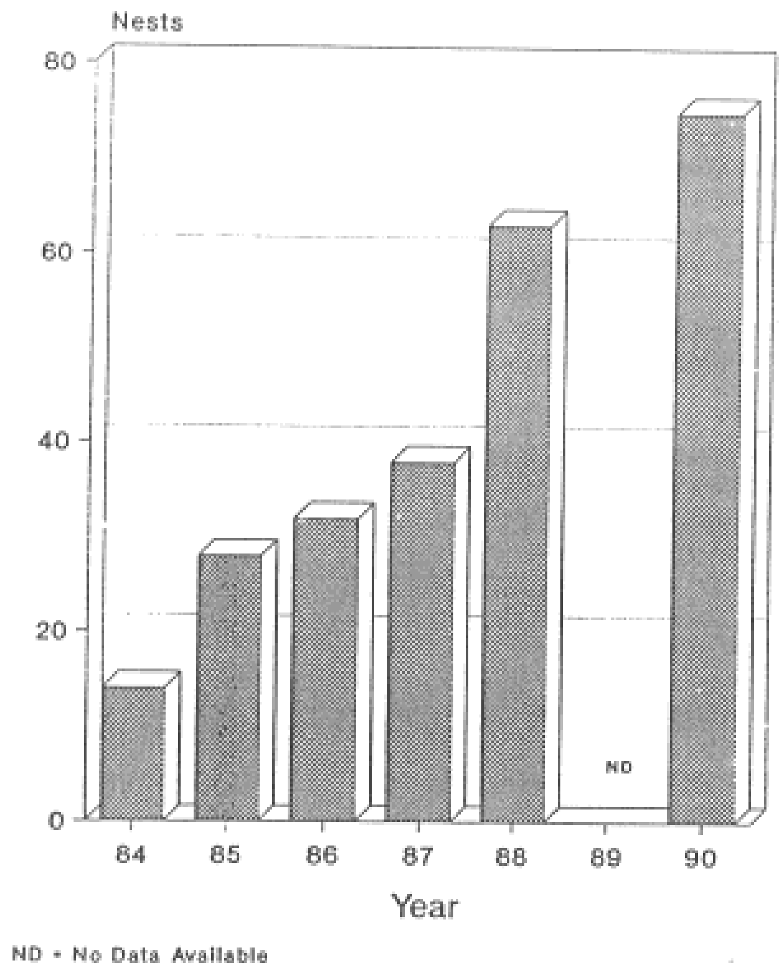


Figure 8. Reproductive effort in Pelagic Cormorants on Anacapa Island, 1984-1990.

CALIFORNIA BROWN PELICAN

California Brown Pelicans (Pelecanus occidentalis californicus) experienced severe, DDT-related reproductive failures in the late 1960's and early 1970's in the Southern California Bight. As a result, the species has been protected since 1970 when they were designated as endangered by the U.S. Fish and Wildlife Service and since 1971 by the state of California (USFWS 1983).

Brown Pelicans breed in the Channel Islands and Los Coronados Islands off Baia California, south to the Mexican mainland at Nayarit. The largest numbers are at the center of the species range in the Gulf of California. Birds nesting in the Southern California Bight include those from the Channel Islands and Los Coronados and are considered to be from the same breeding population.

West Anacapa Island is the site of the largest California Brown Pelican colony in the United States, with 2,000 to 6,000 pair nesting there annually since recovery from acute pollution problems. The colony on West Anacapa has been the northernmost limit of this species' breeding range for the last 40 years.

In 1990, Brown Pelicans nested on West Anacapa and Santa Barbara Islands. On Anacapa, nesting was characterized by a moderate effort, high nest abandonment, and very low productivity. Nesting on Santa Barbara was a small, late effort, with almost no success.

Phenology and Nest Locations

West Anacapa

Females began laying eggs in early February (Table 7) in the Amphitheater, Camel Ridge Bluffs, and East and Middle Interior Bluffs (Fig. 9). By late March, nesting had progressed westward to West Interior Bluff, Summit Canyon Bluff, Oak Canyon Bluff, North Bluff and Three Sisters Bluff (at the latter site, pelicans nested on the upper terrace, an area not used in the last 20 years). Egg laying peaked in mid April and ended by early June.

Pelican chicks started hatching in early March and fledging in early June (Table 7). Peak hatching occurred in mid May, and last chicks hatched in late June. Fledging was complete by late September.

Compared to clutch initiation intervals for the past 20 years, egg laying in 1990 was moderately synchronous, spanning four months (Fig. 10). The shortest period for egg laying was two months (in 1977 and 1983), and the longest interval spanned seven months (in 1985).

Santa Barbara

Pelicans on Santa Barbara Island began laying eggs in late March, nearly two months after pelicans started on Anacapa (Table 7). Peak laying was in mid April. Hatching occurred between late April and early May; most nests had been abandoned prior to hatching. Nesting occurred on the west side of Signal Peak **and in several erosion gullies north of the saddle trail marker; the latter** site is a new nesting area (Fig. 11).

ble 7. Phenology of Brown Pelicans on West acapa and Santa Barbara Islands, 1990.

	West Anacapa	Santa Barbara
g Laying		
Begin	E-Feb	L-March
Peak	M-April	M-April
End	E-June	E-April
tching		
Begin	E-March	L-April
Peak	M-May	None
End	L-June	E-May
edging		
Begin	E-June	L-July
Peak	M-Aug	None
End	L-Sep	None

Early, Days 1-10
Mid, Days 11-20
Late, Days 21-31

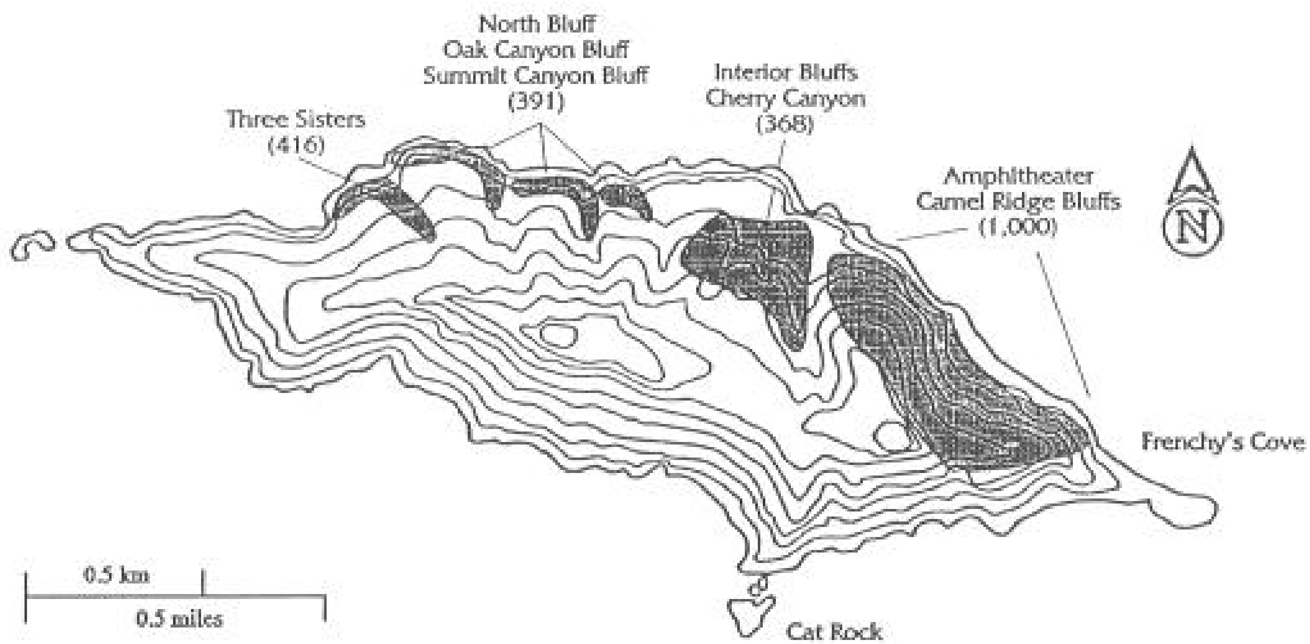


Figure 9. Nesting locations of Brown Pelicans on West Anacapa Island, 1990 (shaded areas; number of nests in each area is in parentheses).

Nesting Effort and Nest Abandonment

West Anacava

A total of 2,175 pairs attempted to nest on West Anacapa Island (Table 8). Two subcolonies comprised over half this effort: 888 pair in the Amphitheater and 416 pair at Three Sisters Bluff (Table 8, Fig. 9). The breeding effort in the other subcolonies ranged from 82 pair at Middle Interior Bluff to 179 pair at Summit Canyon Bluff. This nesting effort was one of the lowest since recovery from acute pollution problems ten years ago. (Fig. 12; App. Q.

Between mid April and mid June, three quarters of the pairs abandoned their eggs or young chicks (Fig. 13). In mid April, during peak laying, only about 6% of nests (132), colonywide, had been abandoned. Two weeks later about 34% (749 nests) - had been abandoned, and by mid May, over half the colony (1,102 nests) was deserted. Thus, most abandonment occurred just after peak hatching (Fig. 13). One month later, in mid June, fewer than 500 nests remained occupied, bringing the rate of nest abandonment to 78%.

Santa Barbara

Total number of nest attempts was 225 (152 on Signal Peak; 73 in gullies) (Table 9). By mid April, 19% (42 nests) had been abandoned. Only 13 active nests remained by the middle of May, bringing the abandonment rate to 94%.

Nesting Success

West Anacapa

Approximately 650 chicks fledged from the entire colony (Table 8). Productivity (fledglings per nest attempt) varied from 0.19 at East Interior Bluff to 0.54

the lowest observed over the past decade (Fig. 14; App. Q.

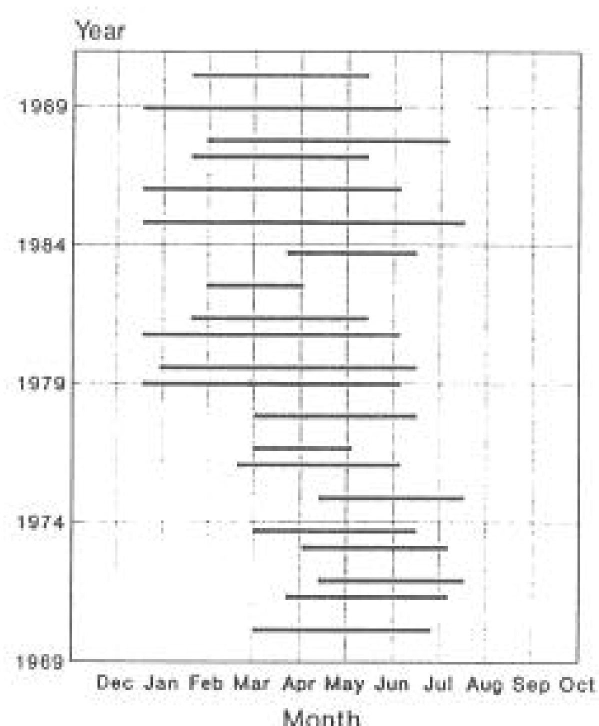
Of 2,175 pairs, 467 (21.5%) successfully fledged at least one young (Table 8). Young fledged per successful nest was 1.39, colonywide.

After most birds had fledged, we surveyed four areas for dead chicks. We found 4, 10, and 9 chicks at West, Middle, and East Interior Bluffs, respectively (Table 8). At Three Sisters Bluff we found 14 dead chicks. Percent mortality for these areas was 19.3 ± 7.9 (mean ± s.d.). Based on this sample death rate, we estimated 155 ± 64 chicks died, colonywide.

Santa Barbara Island

Three chicks fledged from this colony. Productivity was 0.013 (Table 9).

Figure 10. Clutch initiation in Brown Pelicans on West Anacapa Island, 1969-1990.



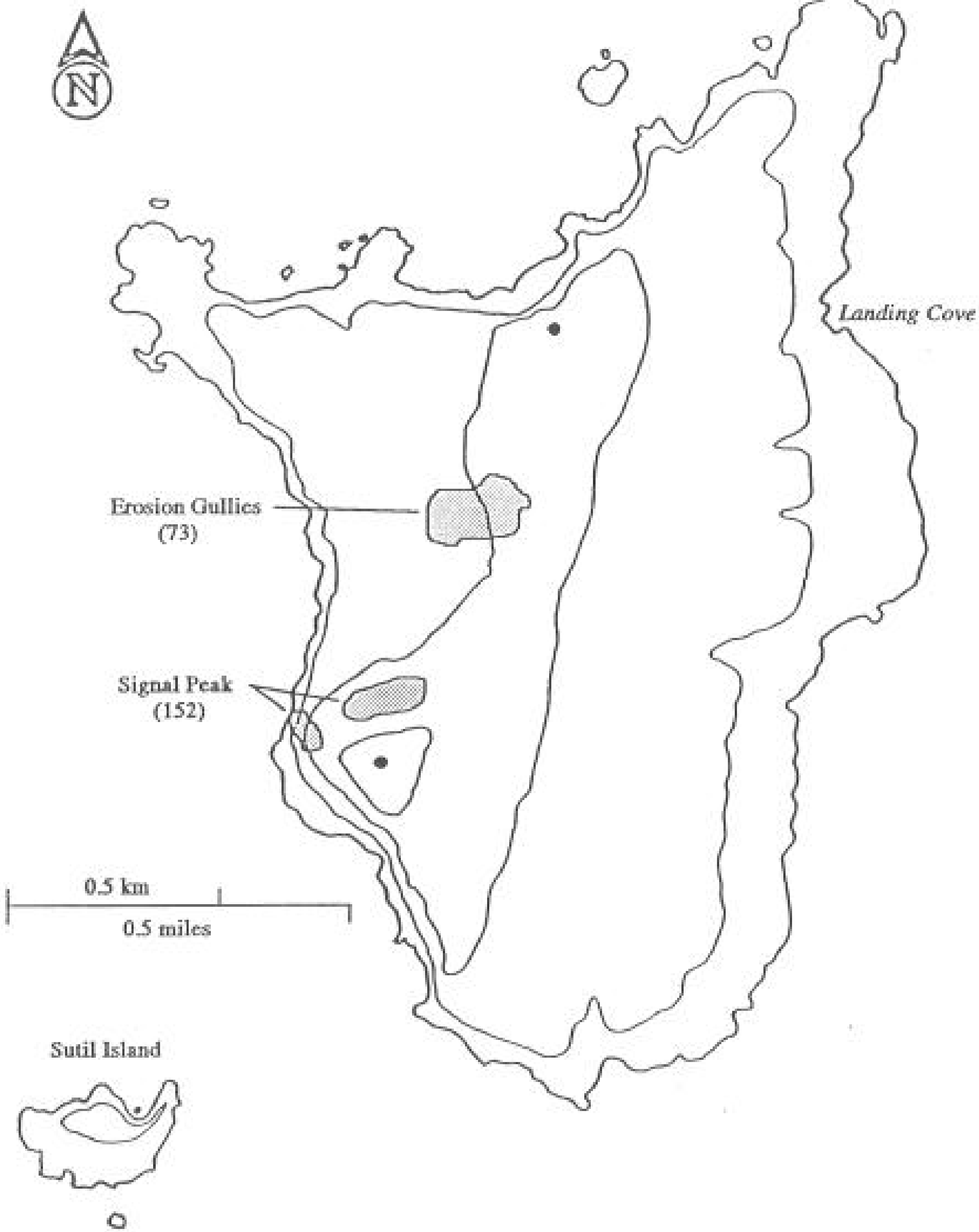


Figure 11. Nesting locations of Brown Pelicans on Santa Barbara Island, 1990 (shaded areas; number of nests in each area is in parentheses).

Table 8. Reproduction in Brown Pelicans on West Anacapa Island, 1990.

Subcolony	Nest Attempts	Nests Abandoned	Young Fledged	Successful Nests	Young Fledged/ Successful Nest	[1]Productivity	Chick Mortality #	%
Three Sisters Bluff	416	353	86	63	1.37	0.21	14	14.0
North Bluff	96	73	35	23	1.52	0.36	ND	
Oak Canyon Bluff	116	75	60	41	1.46	0.52	ND	
Summit Canyon Bluff	179	132	68	47	1.45	0.38	ND	
West Interior Bluff	99	79	30	20	1.50	0.30	4	11.8
Middle Interior Bluff	82	53	35	29	1.21	0.43	10	22.2
East Interior Bluff	89	72	22	17	1.29	0.19	9	29.0
Cherry Canyon	98	78	30	20	1.50	0.31	ND	
Camel Ridge Bluffs	112	68	60	44	1.36	0.54	ND	
Amphitheater	888	725	224	163	1.37	0.25	ND	
Totals	2175	1708	650	467	1.39	0.30	[2](155 ± 64)	(19.3 ± 7.9)

( ) denotes estimated values

[1] Productivity = Young fledged per nest attempt.

[2] Determined from estimated mortality rate, mean ± standard deviation.

ND = not determined.

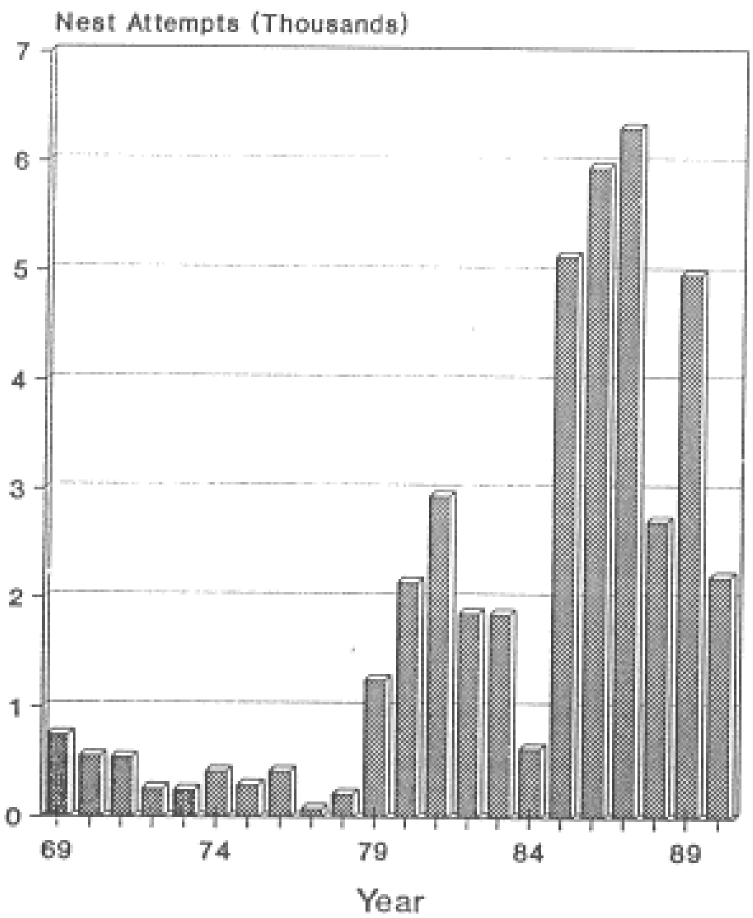


Figure 12. Nest attempts in Brown Pelicans on West Anacapa Island, 1969-1990 (see Appendix C for data sources).

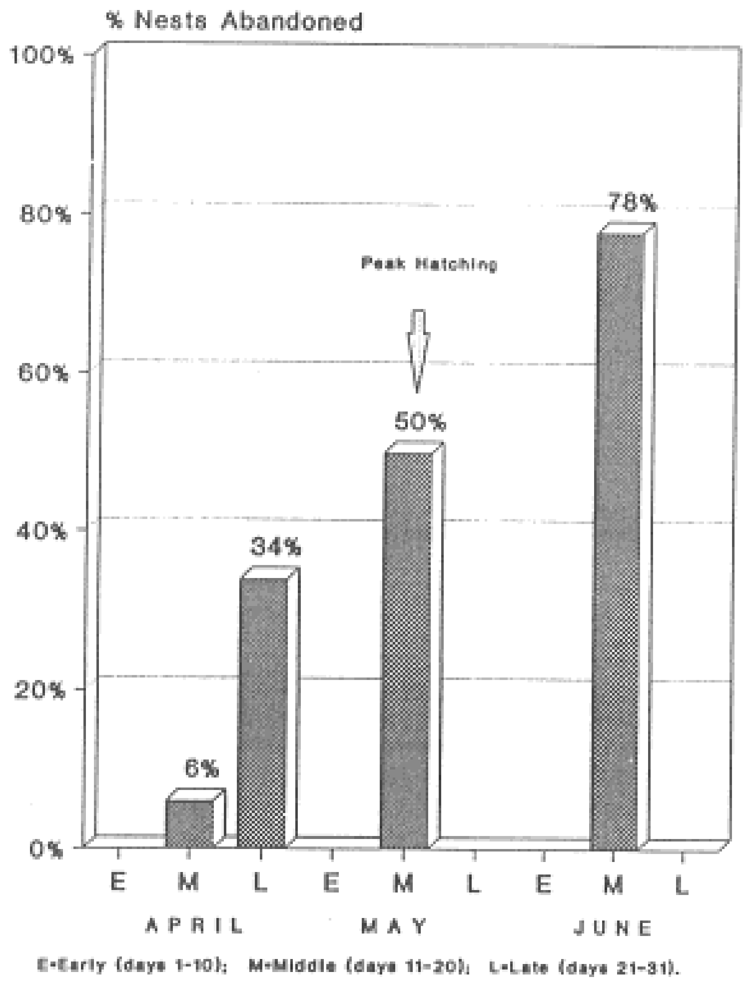


Figure 13. Nest abandonment in Brown Pelicans on West Anacapa Island, 1990.

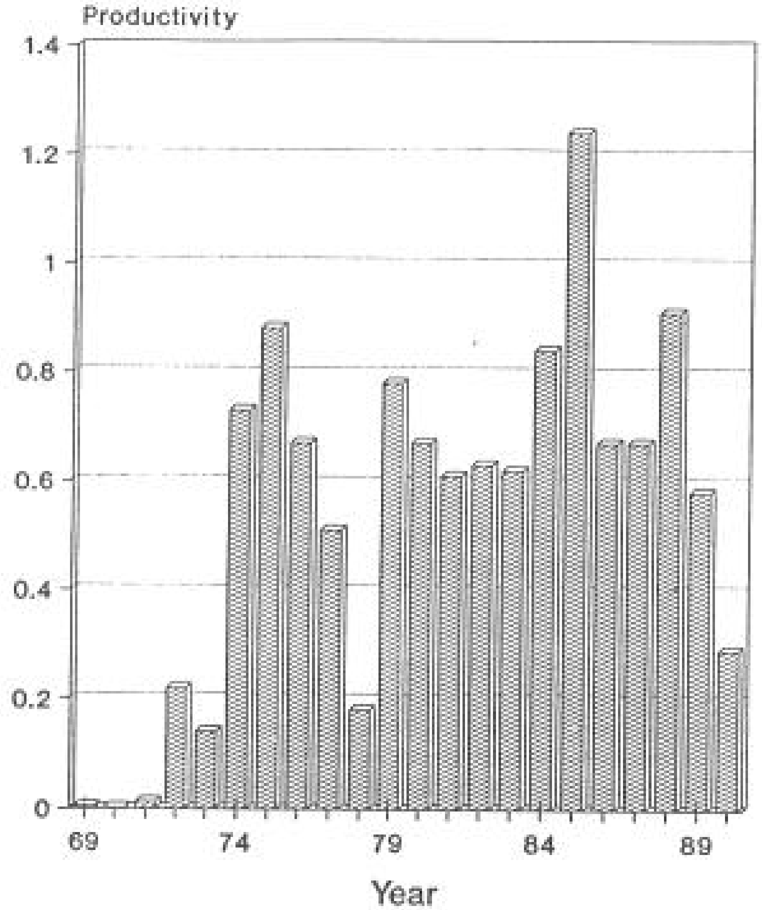


Figure 14. Productivity in Brown Pelicans on West Anacapa Island, 1969-1990 (productivity = fledglings per nest attempt; see Appendix C for data sources).

Table 9. Reproduction in Brown Pelicans on Santa Barbara Island, 1990.

Subcolony	Nest Attempts	Nests Abandoned	Young Fledged	Succ. Nests	Young Fledged/ Succ.nest	Product-ivity	Chick #	Mortality %
Signal Peak Slope	152	151	1	1	1	0.007	11	91.7
Erosion Gullies	73	71	2	2	1	0.027	2	50.0
TOTALS	225	222	3	3	1	0.013	13	81.3

WESTERN GULL

Western Gulls (Larus occidentalis nest on mainland cliffs and offshore islands from southern Washington to northern Baja California. In the park Western Gulls are widespread, breeding on all of the islands; the largest colony is on Anacapa, primarily East and Middle Islands. Gulls build nests in most available terrain, from flat ground, with or without vegetation, to steep, rocky cliffs, and sometimes very close to highly-used visitor trails.

University of California scientists studied Western Gulls on Santa Barbara Island in the 1970's and 1980's. Part of this work resulted in the establishment of five permanent sample plots to study Western Gulf reproductive ecology (Fig. 15, Grids A-E). The park began monitoring gulf reproduction using these plots in 1985, and the data presented here are derived from these samples. Three grids were also established on East Anacapa Island in 1985 (Fig. 16, Grids A-C), at which time monitoring gull reproduction on that island began.

On Santa Barbara, we monitored only grids A, D, and E in 1990; grids 6 and C were excluded due to the proximity of nesting Brown Pelicans. On East Anacapa, grids A and B were monitored; C grid was excluded because there was inadequate cover for chicks.

This season was characterized by a late start, small clutch size, and poor hatching success for Santa Barbara Island gulls; productivity was also low at this colony. On Anacapa, clutch size and hatching success were high, but chick survival, especially in older chicks, was poor; overall productivity on Anacapa was average. At both colonies, chick growth rates were low.

Phenology

On Santa Barbara, clutch initiation was confined to the month of May (Table 10). Females began laying eggs in early May, later than the more typical mid to late April starting dates. The majority of females laid eggs in mid May, and late nesters began clutches by the end of May. Eggs started hatching in late May, most hatched in mid June, and all had hatched by the end of June. Chicks fledged between early July and late August.

On East Anacapa, nesting began about two weeks earlier than on Santa Barbara (Table 10), a typical difference between these colonies. Females began laying eggs in mid April, with the majority starting clutches in late April, and late nesters finishing in mid May. Hatching also began in mid May and continued through mid June. The first chicks fledged in mid July; all chicks had fledged by the middle of August.

Table 10. Phenology of Western Gulls on Santa Barbara and East Anacapa Islands, 1990.

	Santa Barbara	East Anacapa
Egg Laying		
Begin	E-May	M-April
Peak	M-May	L-April
End	L-May	M-May
Hatching		
Begin	L-May	M-May
Peak	M-June	L-May
End	L-June	M-June
Fledging		
Begin	E-July	M-July
Peak	M-July	L-July
End	L-Aug	M-Aug

E=Early, Days 1-10
M=Mid, Days 11-20
L=Late, Days 21-31

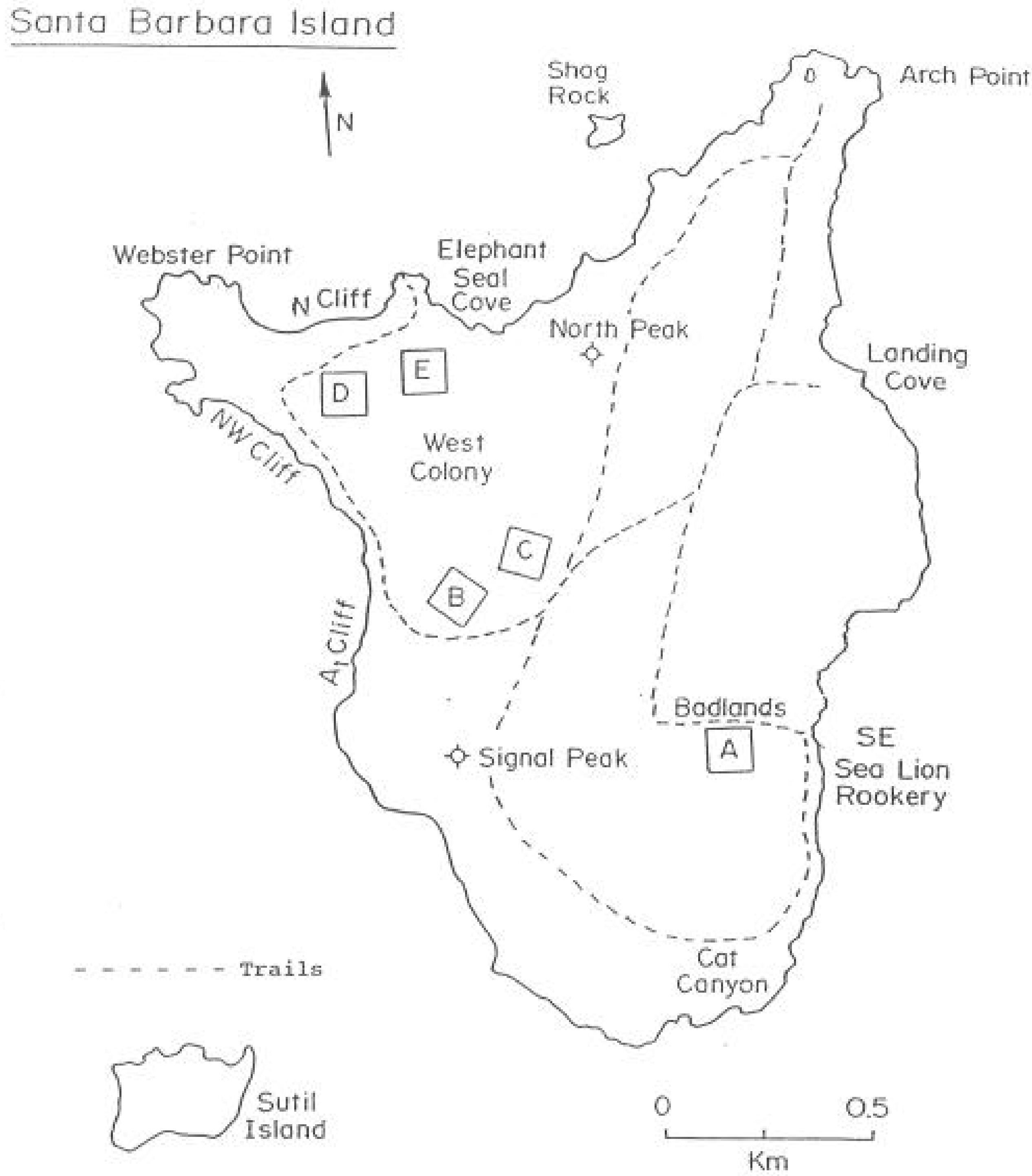


Figure 15. Location of Western Gull sample grids (A-E) on Santa Barbara Island.

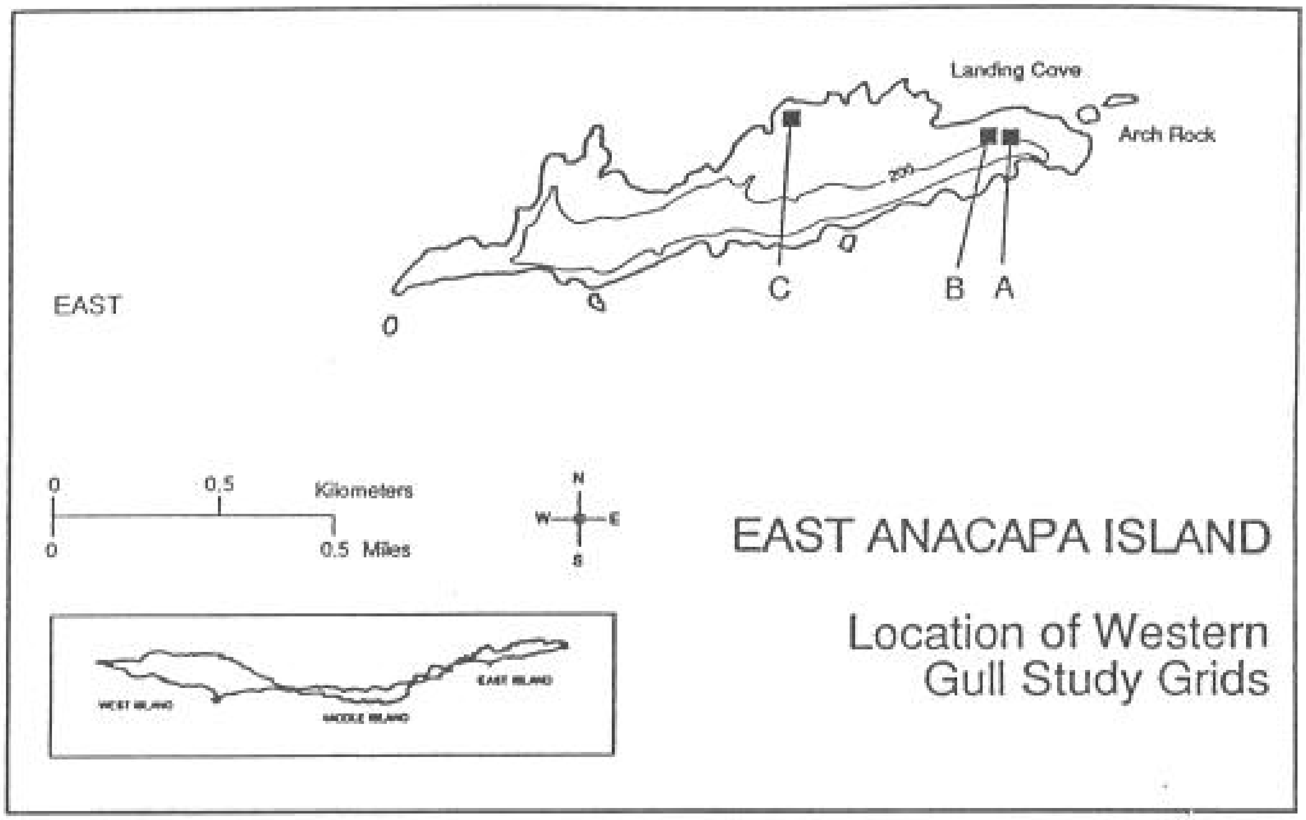


Figure 16. Location of Western Gull sample grids (A-C) on East Anacapa Island.

Reproduction

Data for reproduction are presented in two ways: as raw" data, in Table 11, and as summary data of important events in the breeding cycle (egg laying, hatching success, and fledging success), in Table 12. These transitional stages in the cycle reflect the most stressful periods for breeding adults; how well parents complete each phase provides information needed to evaluate the outcome of an entire reproductive season.

Table 11 summarizes number of nest attempts, eggs laid and hatched, and chicks fledged. In the three grids on Santa Barbara, 83 pairs produced 170 eggs. Of the 102 eggs that hatched, 65 chicks survived to flight age. On East Anacapa, 68 pairs in two grids produced 190 eggs. One hundred sixty two of these eggs hatched, and 81 chicks fledged.

Gulls on Santa Barbara laid fewer eggs than Anacapa gulls (2.05 ± 0.71 and 2.79 ± 0.44, respectively; p<.001), and Santa Barbara eggs were less likely to hatch (0.59 ± 0.43 success) compared to eggs on Anacapa (0.86 ± 0.25 success) (p<.001). Once eggs hatched, however, Santa Barbara gulls raised more chicks to fledging than Anacapa gulls (fledging success: 0.62 ± 0.35 and 0.46 ± 0.36, respectively; p=.006).

No supernormal clutches (clutches of four to six eggs) were observed this season, indicating a relatively even ratio of females to males and possibly a continued recovery from DDT-related problems of the early 1970's (Hunt et al. 1980; Conover and Hunt 1984; Fry and Toone 1981).

Reproductive success and productivity encompass both the egg and chick phases of the breeding cycle, thus reflecting a blend of these two developmental stages. Reproductive success - fledglings per egg - was slightly higher on Anacapa (0.42 ± 0.30) than on Santa Barbara (0.37 ± 0.36), but this difference was not statistically significant (p=.43; Table 12) Productivity - fledglings per pair - was significantly lower on Santa Barbara than on Anacapa (0.77 ± 0.79 and 1.18 ± 0.87, respectively; t=3.05, p=.003).

How fast or slow chicks grow is indicative of food available to parents. Chick growth rates were similar on both islands: on Santa Barbara, chicks gained an average of about 21.5 ± 3.8 grams per day, and on Anacapa, chicks gained about 19.4 ± 4.3 grams per day (p =. 1).

Chick Mortality

The lower fledging success on Anacapa (46%) compared to that on Santa Barbara (62%) was due to higher mortality of chicks on Anacapa (Table 13). One-third of all hatchlings died on Anacapa; on Santa Barbara, 16.7% of hatched chicks died. Additionally, of the chicks that died on Anacapa, 19 (11.7% of hatchlings) were near fledging at the time of death; on Santa Barbara, 4 (3.9% of hatchlings) dead chicks were nearly fledged. Usually, most chicks that attain about one-half of their adult weight, will fledge successfully (Hunt 1972).

Abundance of Breeding Pairs: Total Island Count

Since the early 1970's biologists have estimated colonywide reproductive effort of Western Gulls on Santa Barbara Island by counting all breeding pairs each season (see Seabird Monitoring Handbook, p. 37). Data for the entire colony enhances our ability to establish normal limits of vadability for this population.

Approximately 1,800 pairs nested on Santa Barbara Island in 1990 (Fig. 17). This is well above the longterm mean of just over 1,000 pairs.

Table 11. Reproduction in Western Gulls on Santa Barbara and East Anacapa Islands, 1990.

Location	Grid	Nests	Eggs Laid	Eggs Hatched	Chicks Fledged
Santa Barbara	A	29	63	41	21
	D	31	63	37	27
	E	23	44	24	17
	Total	83	170	102	65
East Anacapa					
	A	34	95	70	30
	B	34	95	92	51
	Total	68	190	162	81

Table 12. Summary of reproductive data in Western Gulls on Santa Barbara and East Anacapa Islands, 1990.

	Santa Barbara (Mean ± sd)	Anacapa (Mean ± sd)	t value	Prob
Clutch Size	2.05 ± .71	2.79 ± .44	7.51	<.001
Hatching Success	0.59 ± .43	0.86 ± .25	4.45	<.001
Fledging Success	0.62 ± .35	0.46 ± .36	2.83	.006
Reproductive Success	0.37 ± .36	0.42 ± .30	0.79	.429
Productivity	0.77 ± .79	1.18 ± .87	3.05	.003
Chick Growth (g/day)	21.48 ± 3.78	19.39 ± 4.26	1.62	.111

Data are from samples: Grids A, D and E on Santa Barbara;
Grids A and B on East Anacapa.

Fledging success = number of fledglings/number of hatchlings
Reproductive success = number of fledglings/number of eggs laid
Productivity = number of fledglings/nest attempt

Fledging success, reproductive success and productivity are averages of the minimum and maximum values for those variables.

Table 13. Mortality in Western Gull chicks on Santa Barbara and East Anacapa Islands, 1990.

Island	Total Chicks Hatched	Total Dead Chicks (#, %)	Older Dead Chicks (#, %)
[1]Santa Barbara	102	17, 16.7	4, 3.9
[2]East Anacapa	162	54, 33.3	19, 11.7

Older chick weighs at least 500 grams.

[1] Grids A, D, and E.

[2] Grids A and B.

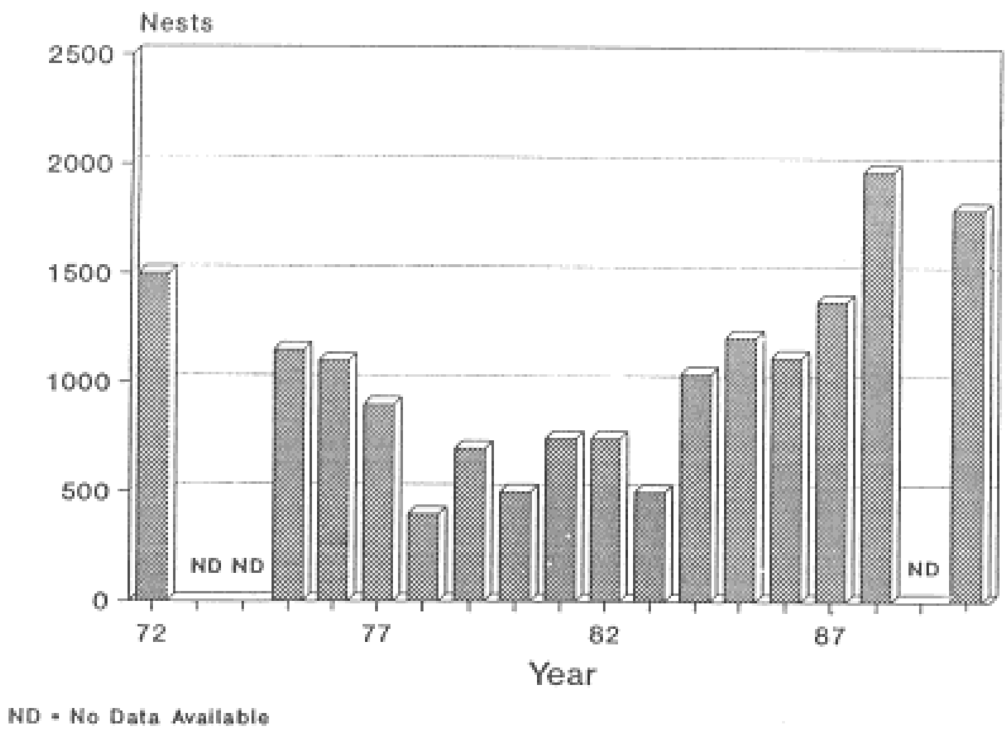


Figure 17. Nest attempts in Western Gulls on Santa Barbara Island, 1972-1990 (data for 1972-84, G.L. Hunt, Jr., unpubl.; for 1985, Lewis and Gress, unpubl. ms; for 1986, Lewis and Gress, 1988; for 1987-89, NPS unpubl. data).

XANTUS' MURRELET

Xantus' Murrelets (Synthliboramt)hus hynoleuca have a small breeding distribution; they nest from the Channel Islands in the north to islands off the west coast of Baja California in the south. The largest known colony of murrelets is on Santa Barbara Island, with estimates ranging from 2,000 to 5,000 pair (Hunt et al. 1979; Murray et al. 1983).

Although murrelets nest all around the periphery of Santa Barbara Island in rock crevices, small caves, and shrubs, nesting areas at Cat Canyon and below the Nature Trail contain the largest accessible aggregations of nests (see Fig. 18). We use permanently tagged nest sites at these locations to monitor murrelet phenology, nesting effort and hatching success each breeding season.

In 1990, the breeding season was short and synchronous and was characterized by low productivity at the Cat Canyon site.

Phenology

At Cat Canyon, egg laying started in early March, about one week earlier than at the Nature Trail site. Similarly, chicks began hatching at Cat Canyon in mid April and in late April at Nature Trail. Last chicks hatched at both sites by the end of May.

Reproduction

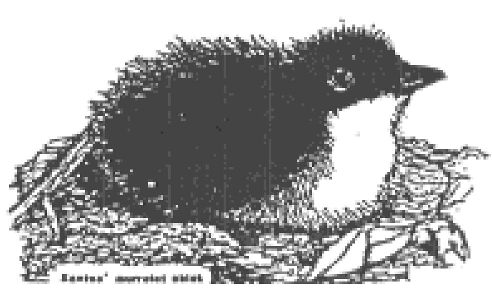
Table 14 summarizes nesting effort and nesting success for the 1990 season. From 109 sites, there were 58 nesting attempts (Table 14a). Of 85 eggs laid, only 31 hatched.

Clutch size was slightly larger at Cat Canyon 0.53 ± 0.57) compared to Nature Trail (1.42 ± 0.48) (Table 14b). Hatching success and estimated productivity were significantly lower at Cat Canyon, with average differences of 32% and 42% respectively, between the two sites.

Hatching success is especially important to document for murrelets because most mortality occurs from predation by endemic mice (Peromyscus maniculatus on unhatched eggs (Murray et al. 1983). Since there is little **known predation on chicks for the short period of time they remain on the** island (2 days), hatching success also provides an estimate of productivity (number of chicks per nest attempt that go to sea and presumably fledge).

Changes

Nest sites have been renumbered sequentially, retagged and mapped accordingly (see Appendix D).



Xantus' murrelet chick

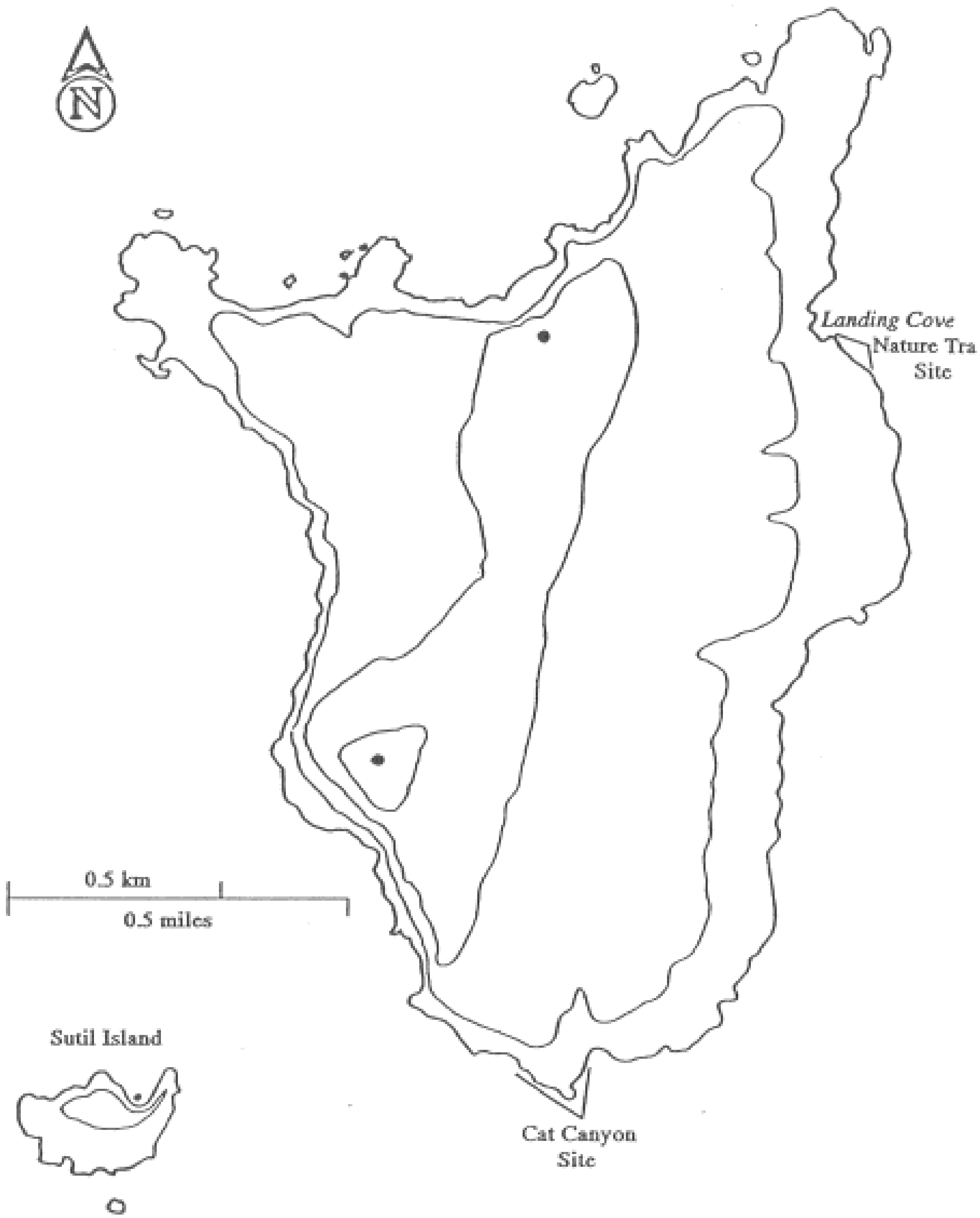


Figure 18. Monitoring sites for Xantus' Murrelets on Santa Barbara Island, 1990.

Table 14. Summary of reproductive data in Xantus' Murrelets on Santa Barbara Island, 1990.

A.

Site	Nest Sites	Nest Attempts	Eggs Laid	Eggs Hatched	Eggs Broken
Nature Trail	51	28	39	20	19
Cat Canyon	[1]58(71)	30	46	11	35
Total	[1]109(122)	58	85	31	54

B.

	Nature Trail (Mean ± s.d.)	Cat Canyon (Mean ± s.d.)	T Value	P
Nest Attempts/Site	0.55 ± 0.64	0.52 ± 0.50	0.29	0.77
Clutch Size	1.42 ± 0.48	1.53 ± 0.57	0.80	0.43
Hatching Success	0.54 ± 0.47	0.22 ± 0.37	2.75	<0.01
Eggs Mortality	0.47 ± 0.47	0.78 ± 0.37	2.75	<0.01
Productivity	0.79 ± 0.77	0.37 ± 0.62	2.26	0.03

[1]Nest sites at Cat Canyon were 71 (bringing the total to 122), but 13 sites were excluded from calculations because shell fragments could not be identified as "hatched" or "broken".

CASSIN'S AUKLET

Cassin's Auklets (Ptychoramphus aleuticus) nest on offshore islands from Alaska to Baja California. They occur on three of the park islands (Santa Barbara, Santa Cruz, Prince), with an estimated 10,000 pair breeding on Prince Island. Cassin's Auklets raise their young preferably in burrows that they excavate each year in loose soil. They also will readily use artificial, man-made structures for nesting.

Monitoring auklet nesting activities in the park is a recent undertaking. To alleviate problems with collapsing burrows, 50 artificial nest boxes (25 each at two locations) were installed on Prince Island in 1986 for this purpose (Fig. 19). In 1990, we obtained data for reproductive effort but not for nesting success (see section on Monitoring Recommendations).

Phenology and Nesting Effort

Most auklets had laid eggs by early April. Eight of ten females laid replacement clutches after the first eggs were taken for toxicological studies. Chicks hatched between late April or early May through early July (three chicks hatched from the July effort; all of these died).

Nesting effort in the boxes has increased each year since monitoring began (Table 15, Fig. 20). For both sites combined, nest attempts have increased from 23 in 1987 to 39 in 1990 (does not include replacement clutches). This represents a change in nest box occupancy from 46% to 78%. If nest box occupancy is similar to that for Cassin's Auklets on the Farallon Islands, the rate can be expected to increase to about 90%, or 45 occupied boxes.

Table 15. Cassin's Auklet reproduction in artificial nest boxes on Prince Island, 1987-1990.

Year	Site	[1]Nest Attempts #	%	Eggs Hatched #	%	Chicks Fledged	Productivity
1987	A	5	20	2	40	4	0.80
	B	18	72	9	50	8	0.44
	Total	23	46	11	49	12	0.52
1988	A	16	64	7	44	4	0.25
	B	19	76	10	53	12	0.63
	Total	35	70	17	49	16	0.46
1989	Data Not Available						
1990	A	21	84				
	B	18	68				
	Total	39	78				

[1] Twenty-five (25) boxes available at each site.

[2] No data on nesting success were obtained in 1990: boxes were not checked for two consecutive months due to summer storms and transportation scheduling conflicts.

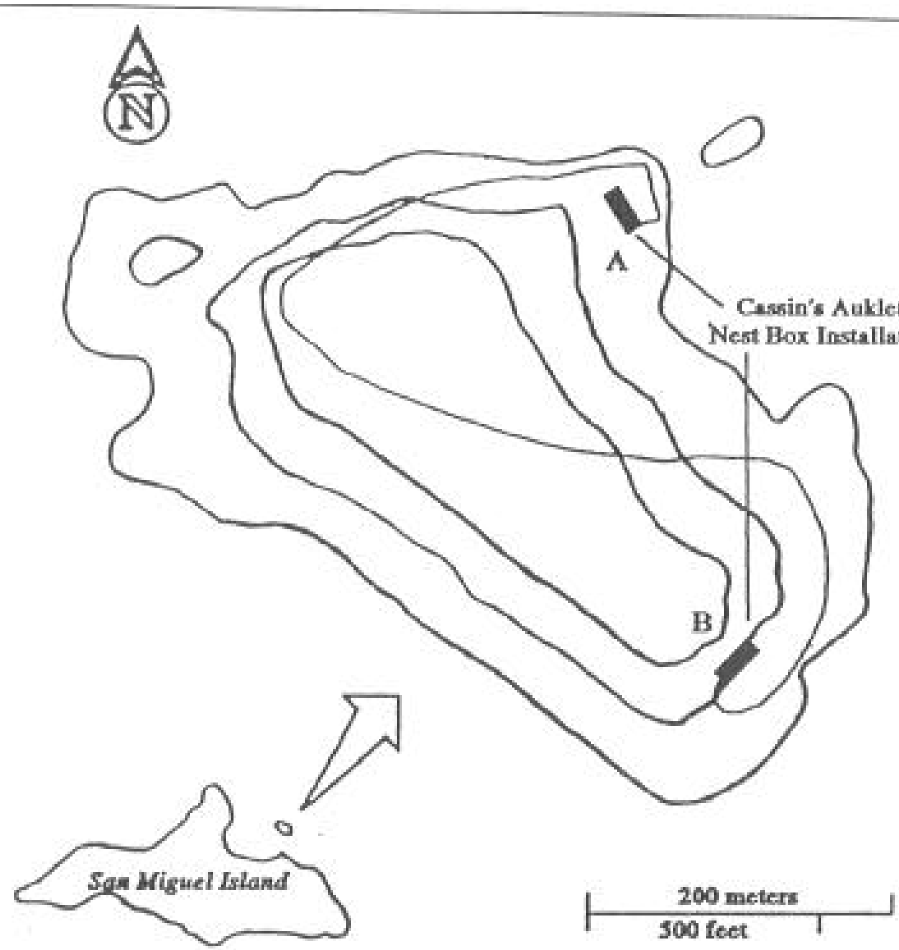


Figure 19. Nest box installations for Cassin's Auklets on Prince Island, 1990.

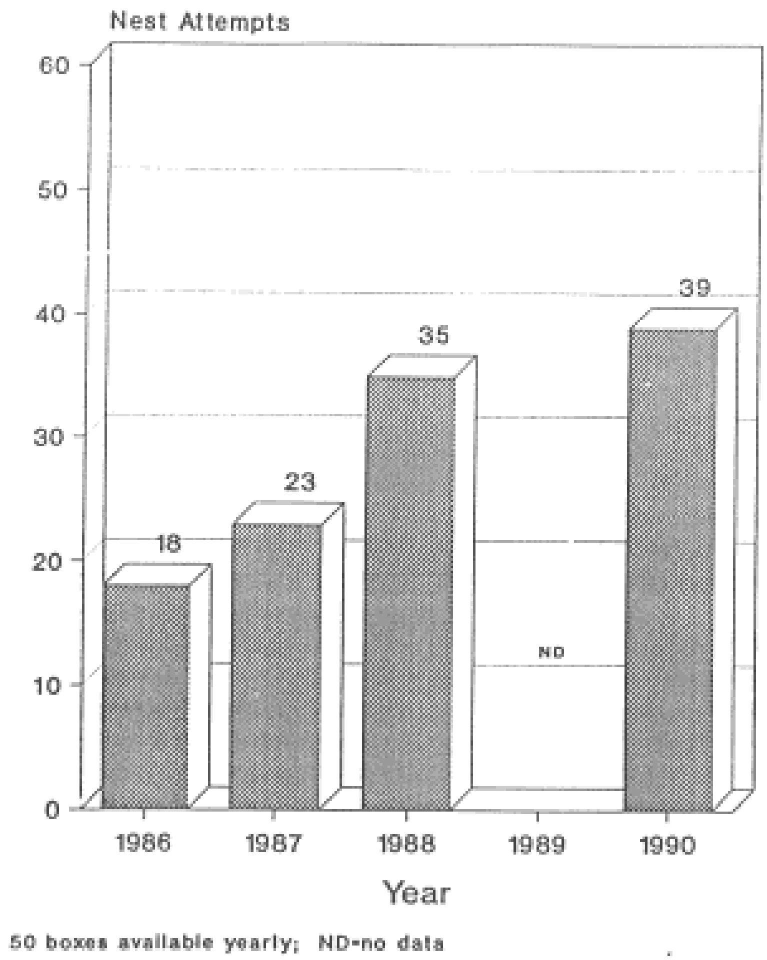


Figure 20. Cassin's Auklet nest attempts in artificial nest boxes, Prince Island, 1986-1990.

The western subspecies of Snowy Plover (Charadrius alexandrinus nivosus) breeds on the mainland west of the Rocky Mountains along the coast from southern Washington to northern Baja California, as well as inland California, Oregon, Nevada, Arizona, New Mexico, and Utah. Snowy Plovers also nest on San Miguel, Santa Rosa, and San Nicolas Islands. Plovers have been monitored on San Miguel Island since 1985 and on Santa Rosa Island since 1989 as part of the Seabird Monitoring Program. Through a Memorandum of Understanding with Point Reyes Bird Observatory (PRBO), biologists conduct Snowy Plover monitoring for the park on these two islands.

Due to loss of appropriate nesting habitat from development, recreation, and natural causes, Snowy Plover abundance has declined 20% in the past ten years in California, Oregon, and Washington (Page et al. 1991). The coastal population of plovers has been listed by USFWS as a Category 1 species - warranted for listing as endangered or threatened.

Snowy Plovers require undisturbed sandy beaches to raise young successfully. If disturbed, a female is likely to abandon her eggs and attempt to breed again. In highly disturbed areas, females have laid as many as five clutches in one season (Warriner et al. 1986), a strategy that is energetically very costly. Because plovers may mate several times in one breeding season, it is very difficult to track actual numbers of nesting pairs. Therefore, a total count of adults, both ma!e and female, provides a minimum estimate of nesting effort. Presently, we do not measure nesting success.

San Miguel Island

One census was conducted on each island in late May. Forty-two (42) adult plovers were seen on San Miguel Island beaches (Table 16; Fig. 21). Most of these were along Simonton Cove 0 3), Cardwell Spit 0 3), and Bowl Cove (9), a new census area (Fig. 20). Two nests were found, one at Cuyler and one at Simonton Cove; and, one brood each was seen at Cuyler and at Bowl Cove.

The counts of breeding adults, like the ones in 1989, were considerably lower than those for 1985 and 1986 (Fig. 22). The cause of this decline is unknown, but may be associated with growing numbers of elephant seals, (Mirounga angustirostris), on these beaches.

Santa Rosa Island

On Santa Rosa Island, 101 adults were observed this year. By far the most active site was the Skunk Point area with 65 breeding adults (Table 16; Fig. 23); three nests were seen in this area as well. There were 8 adults (and one nest) seen up on Old Ranch Canyon Road. Cluster Point Beach and Bee Rock Beach harbored the next highest numbers of plovers with 14 and 12 adults, respectively. Observers found one brood at Soledad Beach and a nest at Mud Tank Beach. Three beaches were censused for the first time in 1990 (Table 16), and eight adults were found at these sites.

Table 16. Number of adult Snowy Plovers on San Miguel and Santa Rosa Islands, 1990.

	Male	Female	Total Adults
San Miguel			
Cuyler Harbor	1	1	2
Simonton Cove	7	6	13
Bowl Cove*	5	4	9
Southeast Beaches	3	2	5
Cardwell Spit	8	5	13
Glass Ball Beach			0
TOTAL	24	18	42
Santa Rosa			
Soledad Beach*	4	1	5
Arlington Beach*			0
Sandy Point*	1	2	3
Mud Tank Beach	1	1	2
Bee Rock Beach	7	5	12
Cluster Point Beach	9	4	14
Skunk Point	38	25	65
TOTAL	60	38	101

* First survey for these beaches done this year.

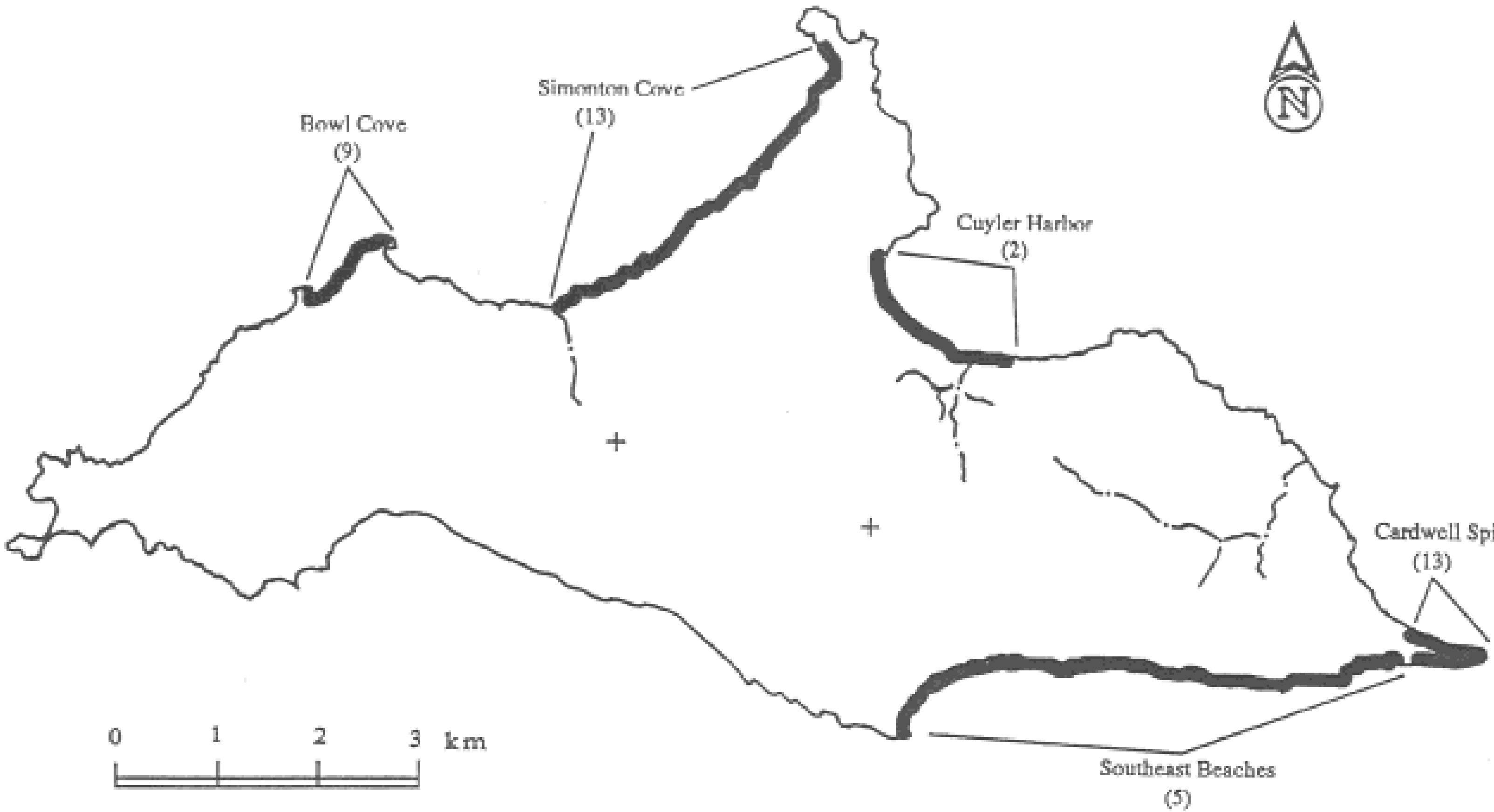


Figure 21. Nesting locations for Snowy Plovers on San Miguel Island, 1990 (bold line; number of breeding adults in each area is in parentheses).

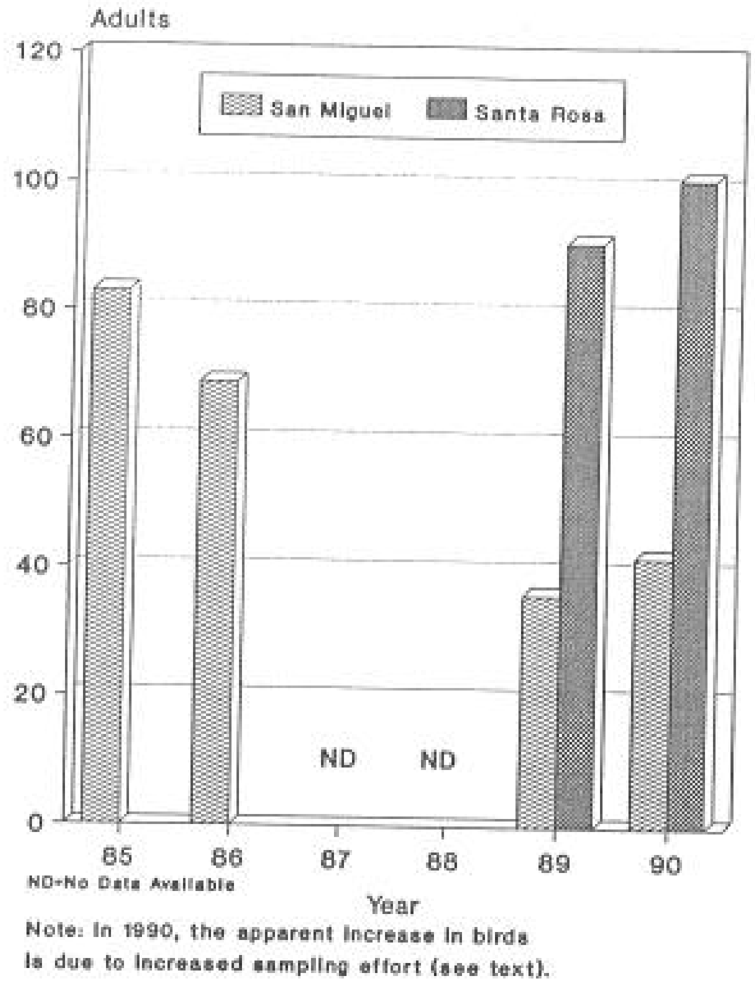


Figure 22. Breeding Snowy Plovers in Channel Islands National Park, 1985-1990.

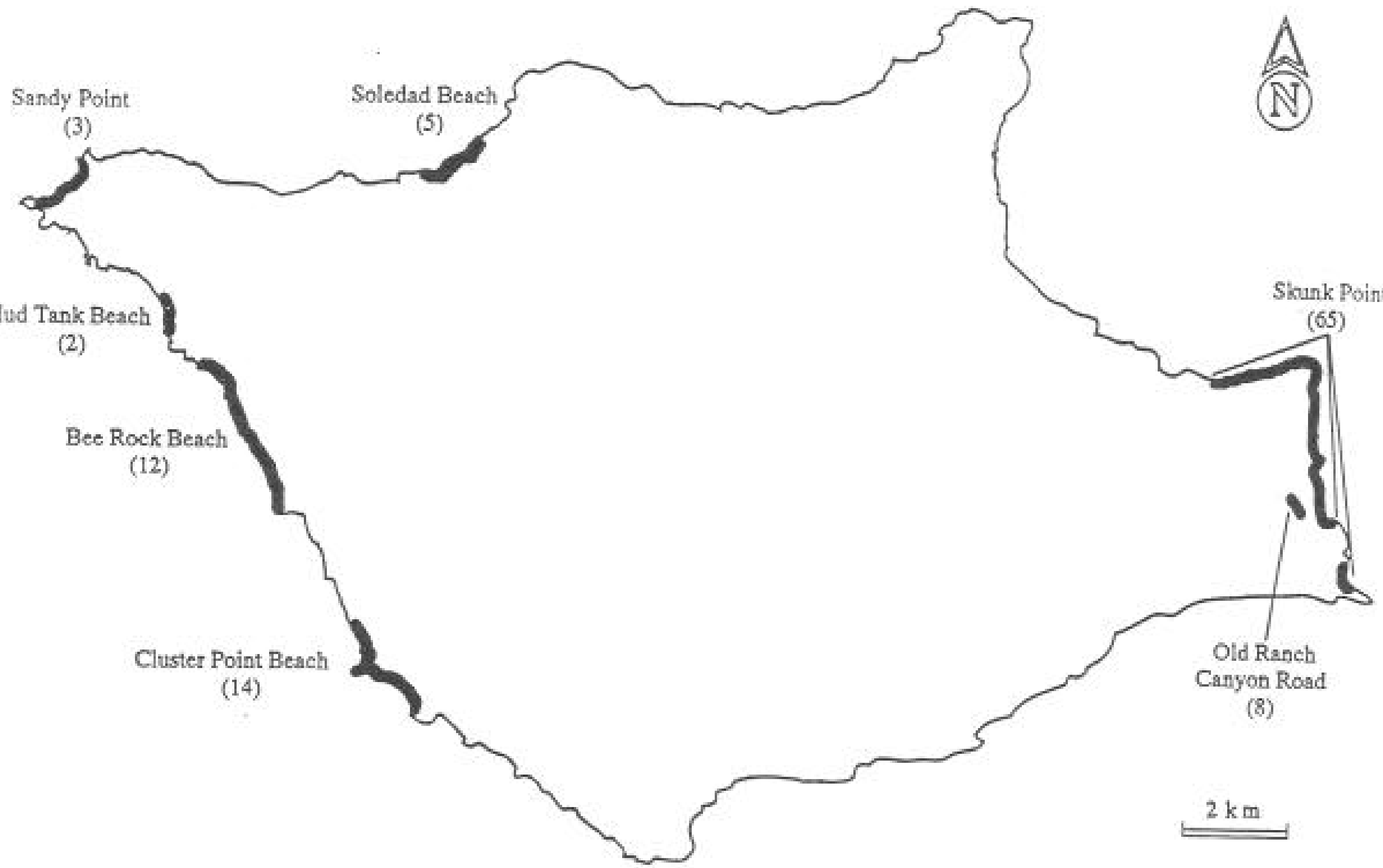


Figure 23. Nesting locations for Snowy Plovers on Santa Rosa Island, 1990 (bold line; number of breeding adults in each area is in parentheses).

MONITORING RECOMMENDATIONS

In this section, we recommend changes in the monitoring protocol and address other related problems.

Double-Crested Cormorant

Prince Island

Counting breeding pairs of Double-Crested Cormorants on Prince Island has been problematic since monitoring began (Lewis and Gress 1986). The main reasons for this are no visibility (some pairs nest on top of the plateau and cannot be seen from below), poor visibility (most of the censusing must be done from a boat to alleviate disturbance), distinguishing between Double-Crested and Brandt's Cormorants when nests from both species are intermixed, and timing of visits due to other park transportation demands or bad weather.

Given these difficulties, the current censusing technique forces us to guess, producing unreliable results. We suggest sampling and aerial photography to help ensure more accurate counts for this difficult to census island. Unless seas are perfectly calm and good counts from a boat can be made, sampling discreet areas, where Brandt's Cormorants do not nest, may be a better approach rather than attempting to obtain a total count for the island.

In addition, getting counts of these sample areas from aerial photos may be a good alternative to boat counts, especially since many of the nests are only visible from above. It may also be possible to obtain a total count of nesting pairs using aerial photography, but this method needs to be tested.

Sutil Island

Censusing Double-Crested Cormorants on top of Sutil Island is hampered by similar conditions as those reported for Prince Island, except that Brandt's Cormorants do , not nest with the double-crests on top of the island. The current technique (long-distance viewing from Signal Peak on Santa Barbara Island) only provides counts of birds in nests at the edge of the cliff face; the majority of nests are not visible from this vantage point or from the water. Therefore, we recommend censusing nesting birds on top of this island using aerial photos.

California Brown Pelican

When pelicans recovered from acute pollutionrelated problems in the early 1980's, it was impossible to predict their numbers would have increased as much as they have. In four of the last six years, the number of pairs breeding on West Anacapa alone has been between 5,000 and 6,300. The difficulty during these high effort years is simply not having enough time to count every nest and chick, given other monitoring requirements.

One possible solution is to continue to obtain total nest counts but with aerial photographs instead of ground counts. This technique has been used successfully to count nests of other seabird species such as cormorants and murres (Carter, et al. 1990), but has not been tested with California Brown Pelicans. We recommend testing this census method using high resolution as well as standard camera formats.

In addition to counting nests from aerial photos, it would be helpful to investigate the possibility of sampling chick production in specific subcolonie,s, rather **than counting each** chick. It may be possible to obtain sample chick counts from aerial photos or from ground counts or both, and estimate productivity from this information.

Western Gull

Santa Barbara Island

We recommend not monitoring grids B and C. Brown Pelicans nesting in or near these grids will continue to preclude monitoring efforts in those plots. Using the remaining three grids for reproductive data provides large enough sample sizes for monitoring purposes.

East Anacapa Island

We recommend not monitoring grid C. The location of this grid has been changed twice in five years because gulf chicks were adversely impacted during monitoring at the previously chosen sites. Unfortunately, this problem persists because the grid's current location is too close to cliffs. Choices of acceptable alternate sites are restricted, perhaps non-existent, on this small, highly-visited island. When the seabird program expands, along with other park operations like transportation, putting reproductive grids on Middle Anacapa may be a better option.

Xantus' Murrelet

Murrelet nest sites require at least weekly visits to obtain information on hatching success. This is because data on egg fates is obtained from eggshell fragments; if sites are not checked shortly after hatching or predation occurs, the shell fragments often disappear or break into pieces too **small to "read" correctly.** Unfortunately, it is not possible for the seabird biologist to be on Santa Barbara Island each week as well as complete other monitoring requirements.

This year there were 13 nests that could not be used for information on hatching success because too much time had elapsed between monitoring visits. Such gaps in data collection can be anticipated to continue until additional staff are available for seabird monitoring.

Cassin's Auklet

Monitoring nest boxes once a month is barely sufficient for obtaining a minimum amount of data on phenology, eggs laid, and chicks hatched. However, if more than one month elapses between visits, information for these variables derived from eggshell fragments or empty boxes is unreliable, and is totally inadequate for any information on nesting success.

Monitoring auklets on Prince Island will continue to be difficult as other demands on park transportation expand. Possible solutions to.this problem include regular assistance from island staff, increased staffing for the seabird monitoring program, and chartering private vessels.

DATA MANAGEMENT

Prior to 1990, a data management system had not been developed for the Seabird Monitoring Program. Data collected from 1985 through 1989 have not been archived. Some summary statistics were calculated for each of those years except 1989. All data for 1985-1989 need to be archived and reanalyzed to compute standard deviations and t-tests so that'appropriate between-year comparis ons can be made. All data collected in 1990 have been archived and analyzed except for data collected for Brown Pelicans on West Anacapa Island.

This chapter is divided into sections by species, as data collection and analysis vary somewhat among species. We include some field methods here for the sake of continuity, although details on methods may be obtained in the Seabird Monitoring Handbook. For each species, we cover data collection, archival, and analysis.

For all species, we enter data into DBase III + files using IBM-compatible personal computers. The DBase file structures have been set up to be the same as the formats for the data sheets used for data collection in the field. The purpose of using DBase is for archival and reorganization of data only; we use SPSS for most of the statistical analyses. We provide commands used to sort files and generate statistics; however, users should know how to access DBase and SPSS and have a general knowledge of these programs.

The following represents a first attempt at data management for this monitoring program. The primary objective is to organize field data in a logical way that will be conducive to subsequent analysis, as well as to do some basic statistical analyses. We recognize that changes to this system will be needed and welcome suggestions for its enhancement. This section will be added to the Seabird Monitoring Handbook.

Double-Crested and Pelagic Cormorants

Data Collection. For Double-Crested Cormorants, colonies are divided into subunits based on natural boundaries or landmarks to facilitate counting. Each subunit or site is drawn on a map of the colony being censused and assigned a number. For Pelagic Cormorants, each sea cave or ledge used for nesting is assigned a number. If possible, we count all nests in a given colony or area, and we estimate total chicks from samples of nests, as chicks are not countable in all nests where they are present. During each census, generally once per month from egg laying through fledging, we record the following variables for both species in a file titled CORM.DBF:

SPECIES	
ISLAND	
YEAR	
MONTH	
DAY	
SITE	Preassigned numbers for subareas
ADULT	Total adults present
TN - W - INC	Total nests with incubating or brooding adults
SN - W - INC	Sample nests with incubating or brooding adults
TN - AB	Total nests abandoned, entered only when all abandoned nests can be counted
SN AB	Sample nests abandoned
SN W CKS	Sample nests with countable chicks
SCHICKS	Number of chicks in sample
N SM CK	Nests with small chicks
SM-CK	Number of small chicks

N_MD - CK	Nests with medium chicks
MD CK	Number of medium sized chicks
N - LG CK	Nests with large chicks
LG - CK	Number of large chicks
SN - TOTAL	Total number of nests in sample
TN-TOTAL	Total number of nests in colony

Groups of nests are selected as samples if some contain countable chicks" (all chicks in a nest can be seen). The number of nests with incubating or brooding adults and the number of abandoned nests in the samr) e are also recorded. The number of nests with small, medium, and large chicks and numbers of chicks in each category are actually subsets of SN - W-CKS (sample nests with chicks) and SCHICKS (number of total chicks in sample), and are used primarily to aid in determined hatching and fledging times.

Data Archival. Index data to group all observations for each site together. (.INDEX ON SPECIES + ISLAND + YEAR + SITE + MONTH + DAY;. USE CORM INDEX CORM). We use the census with the largest number of nests for all subsequent analyses (if there are two discreet nesting attempts in one season, we use both censuses as. if they were separate events but combine them for totals). These records are then selectively transferred to another DBase file titled CORMSAMP.DBF. To select specific records from CORM.DBF to be used in CORMSAMP.DBF:

.USE CORM

(Specifies the working file)

.APPEND FROM CORM FOR ISLAND 'SBI'.AND. SPECIES = 'DCCO'.AND. YEAR = '90' .AND. SITE = 'NPI'.AND. MONTH '06'

(selects the record for Santa Barbara Island, Double-Crested Cormorants, 1990, 'at site NPI for the month of June).

All other designated records are added to CORMSAMP using the APPEND command, as above.

The new file, CORMSAIVIP.DBF, is shown in Figure 24.

Data Analysis. . Using SPSS, we estimate total chicks fledged in a colony and total productivity from the sample productivity and total anticipated fledglings.

We translate CORMSAMP.DBF into an SPSS file and compute two new variables, SAMPPROD and COLYPROD, the sample productivity and colonywide productivity, respectively. Then descriptive statistics for all variables are generated with the following SPSS commands (Fig. 25 shows a sample printout of this procedure):

TRANSLATE FROM = 'F:\HOME\INGRAM\CORMSAMP.DBF''.

SELECT IF (SPECIES EQ 'DCCO' AND ISLAND EQ 'SBI' and YEAR EQ '90').

(Computes statistics for Double-Crested Cormorants on Santa Barbara Island in 1990 only)

COMPUTE SAMPPROD = SCHICKS/SN W CKS.

(Sample productivity= Chicks in sample/sample nests with chicks)

COMPUTE COLYPROD = ((SAMPPROD*SN W INC)+SCHICKS)/SN TOTAL. Colonywide productivity = (chicks fledged per nest attempt) = sample productivity x sample nests with incubating adults (=projected number of chicks to fledge from sample nests that still contain eggs or have undetermined number of chicks) + number of chicks in sample total anticipated chicks in sample nests)/total nests in sample.

DESCRIPTIVES TN W INC TO COLYPROD/STATISTICS =ALL.
(Computes descriptive statistics for all variables)

Using data obtained in the previous step for TN-TOTAL (total nests in colony), we calculate total number of chicks fledged:

COMPUTE CKSFLEGD = Total nests (use actual number) * COLYPROD.

DESCRIPTIVES CKSFLEGD/STATISTICS = ALL.

To compare productivity between islands for the same species, we use the t statistic via the following commands:

SELECT IF (SPECIES EQ'PECO'AND YEAR EQ'90').
(Selects data for Pelagic Cormorants in 1990 only)

T-TEST GROUPS = ISLAND VE - ANAC','W-ANAC')
/VARIABLES SAMPPROD COLYPROD.
(Computes t value for sample productivity and colonywide productivity between East Anacapa and West Anacapa Pelagic Cormorants)

A sample printout is shown in Fig. 26.

If users are unfamiliar with SPSS, please be aware that all apostrophes, parentheses, periods, and punctuation in general must be strictly adhered to, or programs will not run. For a printout of results, use the command, SET PRINTER = ON., as the first command for all programs. To save commands, use function key F9; to retrieve, use F3.

California Brown Pelican

Data Collection and Archival. Tracking Brown Pelican nests through a season is more difficult than for the other monitored species because their nesting is generally highly asynchronous and nest abandonment rates are usually high. Boundaries for subcolony areas must be as precise as possible. Data are collected once per month and entered into the following DBase file, BRPE.DBF:

SPECIES	
ISLAND	
YEAR	
MONTH	
DAY	
SITE	A numbered code, described in another file (BRPESITE.DBF)
ADULTS	In early nesting phase, total adults in breeding plumage, not on nests
N_W_INC	Nests with incubating or brooding adults
AB-N	Nests abandoned since previous census
N_W_CKS	Nests with chicks in nest or clearly associated with a nest
NEW-N	New nests since previous census, not entered in the field
CKS-AGE1	Number of chicks, aged 1-3 weeks
AGE1	Chick ages in weeks
CKS-AGE2	Number of chicks, aged 4-6 weeks
AGE2	Chick ages
CKS-AGE3	Number of chicks, aged 7-9 weeks
AGE3	Chick ages
CKS-AGE4	Number of chicks, aged 10-13 weeks
CKS-DEAD	Dead chicks and approximate age at death (from post-season survey of colony or portions of colony)
COMMENTS	

Recording actual chick ages helps determine phenology, as well as tracking number of chicks that fledge.

Data Analysis. INDEX file by site as for cormorants, above. Print out indexed file and determine new nests (NEW - N) for each census by tracking new nests from previous census and number of abandoned nests. After all nests can be accounted for, NEW N and AB N are totalled to obtain total nest attempts and total abandoned nests, repectively. Total chicks fledged is calculated by hand from counts of older chicks minus any older chicks found during the mortality count. From these results, we calculate successful nests (total attempts - total abandoned), and productivity (fledglings per nest attempt).

Western Gull

Data Collection. We follow samples of nests in grids from the time the first egg is laid through the time chicks attain weights of 500-1000 grams. Variables recorded are these:

SPECIES	
ISLAND	
YEAR	
MONTH	
DAY	
GRID	Letter AACA or E
NEST	Nest numbers
NEW EGG	Number of eggs since previous visit
OLD EGG	Number of eggs from previous visit
PIPPED	Pipped eggs
BKN/DEAD	Nonviable eggs (broken or dead)
MISSING	Eggs missing since previous visit
BAND1	USFWS band number for first chick
CK CAUT1	First chick caught
GRZOSS WT1	Chick weight + bag weight, first chick
TARE WT1	Bag weight for first chick
CK ESC1	First chick seen at nest but escaped
CK NF1	First chick present on a previous census, but not found this date
CK DEAD1	First chick found dead
BAND2	For second chick
CK CAUT2	
GROSS WT2	
TARE WT2	
CK ESC2	
CK NF2	
CK DEAD2	
BAND3	For third chick
CK CAUT3	
GROSS-WT3	
TARE WT3	
CK ESC3	
CK NF3	
CK DEAD3	
COMMENTS	

Data Archival. All data for each census are archived into WEGU.DBF. Index to track each nest (.INDEX on ISLAND + YEAR + GRID + NEST + MONTH + DAY; Use WEGU INDEX WEGU).

Using the indexed file, summary data for clutch size, chicks hatched, and chicks fledged are tallied by hand for each nest and entered into another DBase file, WGSUM.DBF, with the following variables:

YEAR	
ISLAND	
SPECIES	
GRID	
NEST	
CLCH SIZ	Clutch size
CKS HACH	Total number of chicks hatched
MIN - FLEG	Minimum numb er of chicks ' fledged (see below)
MAX - FLEG	Maximum number of chicks fledged (see below)
COMMENTS	

A sample printout of WGSUM.DBF is shown in Fig. 27.

Data Analysis. We translate WGSUM.DBF into an SPSS file, compute new variables, and generate descriptive statistics and t-tests. We compute hatching success (eggs hatched/egg laid), fledging success (chicks fledged/hatched egg) reproductive success (chicks fledged/egg laid), productivity (chicks fledged/nest attempt), and chick growth rates.

In some years, censuses may not be as frequent as necessary to obtain precise data on number of chicks actually fledged. If this is the case (as in 1990) we estimate fledglings from the average of the minimum number likely to fledge and the maximum number likely to fledge. Minimum chicks fledged are those that attain a weight of at least 500 grams on the last visit; maximum chicks'fledged are those that were found on the previous two visits, weighed at least 300 grams on the last visit, and were not found dead during the post-season mortality count (i.e. the chick was alive, but we could not find it). Thus, we compute the following variables and run the following tests:

TRANSLATE FROM = 'F:XHOMNNGRAM\WGSUM.DBF'

COMPUTE HACHSUCC = CKS HACH/CLCH SIZ.
(Hatching success = chickshatchediclutch size)

COMPUTE MINFSUCC = MIN FLEG/CKS HACH.
(Minimum fledging success = Minimum chicks fledged/chicks hatched)

COMPUTE MAXFSUCC = MAX FLEG/CKS HACH.
(Maximum fledging success = Maximum chicks fledged/chicks hatched)

COMPUTE FLEGSUCC = (MINFSUCC + MAXFSUCC)/2.
(Fledging success = Average of minimum and maximum fledging success)

COMPUTE MINREPRO = MIN FLEG/CLCH SIZ.
(Minimum reproductive success = Minimum chicks fledged/clutch size)

COMPUTE MAXREPRO = MAX FLEG/CLCH SIZ.
(Maximum reproductive success = Maximum chicks fledged/clutch size)

COMPUTE REPROSUC = (MINREPRO + MAXREPRO)/2.
(Reproductive success = Average of minimum and maximum reproductive success)

COMPUTE PRODUCT (MIN - FLEG + MAX-FLEG)/2.
(Productivity Average of minimum and maximum chicks fledged per nest attempt)

SELECT IF (ISLAND EQ'SBI'AND GRID EQ'A').
(Computes statistics only for gulls on Santa Barbara Island and in Grid A, for example)

DESCRIPTIVES CLCH SQ TO PRODUCT/STATISTICS =ALL.
(Computes summary statistics for all variables in the file including computed variables)

A sample printout of these results is shown in Fig. 28.

To generate t statistics, delete the SELECT IF command and proceed as follows:

T-TEST GROUP = ISLAND VSBI', 'EAI')
NARIABLES CLCH - SIZ HACHSUCC FLEGSUCC REPROSUC PRODUCT.
(Computes t statistic for these variables for gulls on
Santa Barbara and East Anacapa Islands)

If censuses can be done more often (about once per week), calculations can be reduced as follows:

COMPUTE HACHSUCC = CKS-HACH/CLCH-SIZ.

COMPUTE FLEGSUCC = CKS-FLEG/CKS-HACH.

COMPUTE REPROSUC = CKS-FLEG/CLCH-SIZ.

COMPUTE PRODUCT = CKS-FLEG.

Growth Rates. We take weight measurements on chicks when they weigh between 100 and 600 grams (when growth is most rapid). We prefer at least three weights per chick but two will suffice if the interval between weights is long enough for the chick to have attained at least 500 grams. Using WEGU INDEX WEGU, select chicks by band number that meet these criteria, the weights to be used for calcuiating growth (first and last only), and calculate the number of days between the first and last weights.

These data are entered into a file titled GROWRATE.DBF, which is then translated into SPSS as follows:

TRANSLATE FROM = 'F:\HOME\INGRAM\GROWRATE.DBF'.

COMPUTE CHICKWT = CKWTTWO-CKWTONE.
(Chick weight = last weight minus first weight)

COMPUTE GROWRATE = CHICKWT/DAYS.
(Growth rate in grams per day = chick weight/number of days between weights)

T-TEST GROUPS = ISLAND ('SBI', 'EAI')NARIABLES GROWRATE.
(Computes differences in growth rates between gulls on Santa Barbara
and East and East Anacapa Islands)

Xantus' Murrelet

Data Collection. Marked nests are followed at two sites on Santa Barbara Island from egg laying through hatching. Nests are checked weekly for the presence of eggs, adults, and hatchlings. The highly precocial chicks leave the island two days after hatching, so there is no nestling period on the island, as with the other monitored species. We use hatching success as an index to productivity.

Data Archival. We summarize field data by hand and enter it into XAMUSUM.DBF with the following variables:

ISLAND	
SPECIES	
YEAR	
SITE	Two letter code
NEST	From tagged nest locations
ATTEMPTS	One nest attempt = one or two eggs laid (two eggs maximum per attempt)
EGGS LAID	Number of eggs laid
EGGS HACH	Number of eggs hatched
EGGS BKN	Number of eggs destroyed by mice
EGGS ABND	Number of eggs abandoned
CKS DEAD	Dead chicks
CKS_FLGD	Hatched chicks - dead chicks

The printout for this file is similar to the one shown for Western Gulls in Fig. 27.

Data Analy§111. From SPSS we cor-npuie descriptive statistics for each site and compare variables ***between sites*** using t-tests:

TRANSLATE FROM = 'F:\HOME\INGRAM\XAMUSUM.DBF'

COMPUTE CLCH SIZ = EGGS LAID/ATTEMPTS.
(Clutch ***size*** = eggs laid/nest attempts)

COMPUTE HACH - SUC = EGGS-HACH/EGGS-LAID.
(Hatching success = eggs hatched/eggs laid)

COMPUTE EGG - MORT = EGGS - **BKN/EGGS -LAID.**
(Egg mortality = eggs broken/eggs laid)

COMPUTE PRODUCT (EGGS HACH-CKS DEAD)/ATTEMPTS.
(Productivity eggs hatched-dead ~hicksffiest attempts)

SELECT IF (SITE EQ'CC').
(For example, computes statistics for site at Cat Canyon (CC) only)

DESCRIPTIVES ATTEMPTS TO PRODUCT/STATISTICS=ALL.
(Computes descriptive statistics for all variables).

T-TEST GROUP = SITE ('TS','CC')NARIABLES ATTEMPTS TO PRODUCT.
(Computes differences between sites for all variables named in
the DESCRIPTIVES command, above)

Cassin's Auklet

Data Collection. We collect data once monthly, weather and boat schedules permitting. We check each nest box twice per trip (upon arrival in the afternoon and the following morning) to obtain data on both parents, since adults switch incubation duties each night.

Data Archival. Data for the following variables are saved in a DBase file titled CAAU.DBF:

ISLAND	Prince
SPECIES	
YEAR	
MONTH	
DAY	
SITE	A or B
BOX	1-25
EGGS LAID	Number of eggs laid
HACH EGG	Number of eggs hatched
BRK EGG	Number of broken eggs
ADULT	Number of adults present
AD BAND	Adult band number, USFWS
REEAP	Number of adults recaptured from previous years
LIVE CK	Number of live chicks present
DEAD CK	Number of dead chicks
CK BAND	Chick band number, USFWS
CKGRSWT	Gross weight = weight of chick + bag
TAREWT	Bag weight
COMMENTS	

We create an index file (.INDEX ON YEAR + SITE + BOX + MONTH + DAY) and enter summary data for each nest into a file titled CAAUSUM.DBF. Variables are species, island, year, site, box, eggs laid, eggs hatched, and chicks fledged.

Data AnalyaLis. Descriptive statistics are calculated using SPSS as follows:

TRANSLATE FROM = 'F:\HOME\INGRAM\CAAUSUM.DBF'

COMPUTE PRODUCT CK - FLDG/EGG-LAID.
(Productivity chicks fledged/eggs laid; since clutch size = 1, eggs laid = attempts)

COMPUTE FLDGSUC = CK FLDG/EGG HCH.
(Fledging success = chicks fle4ed/eggs hatched)

DESCRIPTIVES EGGS - LAID TO FLDGSUC/STATISTICS =ALL.
(Computes descriptive statistics for all variables)

Other information of biological interest that may be calculated from these data include nest site fidelity and chick growth rates. Data on nest site fidelity has not been analyzed and data for growth rates requires that more weights be taken during the nestling period.

Snowy Plover

Data Collection and Archival. We count breeding adult male and female plovers on all accessible beaches on San Miguel and Santa Rosa Islands. We also record number of nests and broods if found. We enter these data by census area (numbers are assigned to specific beaches) and simply compute total number of adults. The following DBase structure is for a file titled SNPL.DBF:

DATE	
ISLAND	
SPECIES	
SITE	Preassigned number
FEMALES	ı otal number of breeding females
MALES	Total number of breeding males
TOT AD	Total number of adults (females + males)
NESTS	Number of nests seen
CHICKS	Number of chicks seen
COMMENTS	SITE description

Record#	SPECIES	ISLAND	YEAR	MONTH	DAY	SITE	TN_W_INC	SN_W_INC	SN_W_CKS	SCHICKS	SN_TOTAL	TN_TOTAL
42	DCCO	SBI	91	07	21	NP1	8	8	22	41	39	39
43	DCCO	SBI	91	06	26	NP2	25	0	0	0	0	25
44	DCCO	SBI	91	06	26	NP3	0	0	0	0	0	2
45	DCCO	SBI	91	06	26	NP4	10	0	0	0	0	10
46	DCCO	SBI	91	06	26	NP5	2	0	0	0	0	2
47	DCCO	SBI	91	06	26	NP6	20	0	0	0	0	20
48	DCCO	SBI	91	06	26	NP7	2	0	0	0	0	2
49	DCCO	SBI	91	06	26	STL	60	0	99	99	0	60
50	DCCO	SBI	91	06	27	WC1	22	0	99	99	0	22
51	DCCO	SBI	91	06	27	WC2	28	0	99	99	0	28
52	DCCO	SBI	91	06	27	WC3	27	0	99	99	0	27
53	DCCO	SBI	91	07	21	WC4	25	0	99	99	0	25
54	PECO	EAI	90	06	07	001	1	1	0	0	1	1
55	PECO	EAI	90	06	07	002	1	1	2	3	3	3
56	PECO	EAI	90	06	07	003	3	3	2	2	7	7
57	PECO	EAI	90	06	07	005	7	7	7	11	14	14
58	PECO	EAI	90	06	07	006	0	0	1	2	1	1
59	PECO	WAI	90	06	15	001	0	0	2	3	2	2
60	PECO	WAI	90	06	15	004	2	2	2	4	4	4
61	PECO	WAI	90	06	15	007	2	2	3	6	7	7
62	PECO	WAI	90	06	15	02A	0	0	1	1	2	2
63	PECO	WAI	90	06	15	02B	0	0	5	7	5	5
64	PECO	WAI	90	06	15	03C	6	6	3	5	10	10
65	PECO	WAI	90	06	15	05A	3	3	3	7	6	6
66	PECO	WAI	90	06	15	05B	0	0	2	5	2	2
67	PECO	WAI	90	06	15	05C	1	1	1	2	2	2
68	PECO	WAI	90	06	15	05D	2	2	0	0	2	2
69	PECO	WAI	90	06	15	06B	1	1	0	0	1	1
70	PECO	WAI	90	06	15	06C	1	1	1	1	2	2
71	PECO	EAI	91	06	30	001	2	2	4	7	6	6
72	PECO	EAI	91	06	30	002	2	0	99	99	0	3
73	PECO	EAI	91	06	30	004	3	3	7	15	10	10
74	PECO	EAI	91	06	30	005	3	3	11	24	14	14
75	PECO	EAI	91	06	30	006	0	0	2	3	2	2
76	PECO	MAI	91	06	30	001	3	3	1	2	4	4
77	PECO	MAI	91	06	30	002	3	3	6	14	9	9
78	PECO	WAI	91	06	30	001	0	0	2	4	3	3
79	PECO	WAI	91	06	30	004	5	5	4	8	9	9
80	PECO	WAI	91	06	30	007	4	4	5	11	9	9
81	PECO	WAI	91	06	30	02B	5	5	2	3	7	7
82	PECO	WAI	91	06	30	02C	4	4	1	1	5	5
83	PECO	WAI	91	06	30	03A	1	0	99	99	0	1

Figure 24. Selected fields from CORMSAMP.DBF, showing sample file structure for Double-Crested and Pelagic Cormorants (99=missing values).

Figure 25. Sample SPSS descriptive statistics using CORMSAMP.DBF.

```
--------------------------------------------------------------------------------
Page  42                        SPSS/PC+                              10/23/92

This procedure was completed at 11:31:23
MISSING VALUES SW_W_INC TO SW_TOTAL (99).
SELECT IF (SPECIES EQ 'DCCO' AND ISLAND EQ 'SBI' AND YEAR EQ '90').
COMPUTE SAMPPROD=SCHICKS/SW_W_CKS.
COMPUTE COLYPROD=((SAMPPROD * SW_W_INC) + SCHICKS)/SW_TOTAL.
DESCRIPTIVES TW_W_INC TO COLYPROD/STATISTICS=ALL.
The raw data or transformation pass is proceeding
     13 cases are written to the uncompressed active file.

WARNING 11003
PAGE TOO NARROW TO PRINT COLUMNAR STYLE DESCRIPTIVE STATISTICS--Too many
statistics are requested to print them in columns.  Serial format is used.

--------------------------------------------------------------------------------
Page  43                        SPSS/PC+                              10/23/92


Number of Valid Observations (Listwise) =         7.00

Variable  TW_W_INC

Mean           14.923            S.E. Mean        4.061
Std Dev        14.643            Variance       214.410
Kurtosis        1.411            S.E. Kurt        1.191
Skewness        1.346            S.E. Skew         .616
Range          48.000            Minimum              2
Maximum            50            Sum            194.000

Valid Observations -       13        Missing Observations -        0
--------------------------------------------------------------------------------
Page  44                        SPSS/PC+                              10/23/92

Number of Valid Observations (Listwise) =         7.00

Variable  SW_W_INC

Mean           11.889            S.E. Mean        3.025
Std Dev         9.075            Variance        82.361
Kurtosis        1.545            S.E. Kurt        1.400
Skewness        1.048            S.E. Skew         .717
Range          29.000            Minimum              2
Maximum            31            Sum            107.000

Valid Observations -        9        Missing Observations -        4
--------------------------------------------------------------------------------
```

Figure 25. Sample SPSS descriptive statistics using CORMSAMP.DBF.

```
-----------------------------------------------------------------------------------
Page  47                          SPSS/PC+                                10/23/92

Number of Valid Observations (Listwise) =        7.00

Variable  SW_W_CKS

Mean              2.444              S.E. Mean        .626
Std Dev           1.878              Variance        3.528
Kurtosis           .538              S.E. Kurt       1.400
Skewness           .475              S.E. Skew        .717
Range             6.000              Minimum            0
Maximum               6              Sum           22.000

Valid Observations -        9        Missing Observations -        4
-----------------------------------------------------------------------------------
Page  48                          SPSS/PC+                                10/23/92

Number of Valid Observations (Listwise) =        7.00

Variable  SCHICKS

Mean              3.667              S.E. Mean        .928
Std Dev           2.784              Variance        7.750
Kurtosis          -.787              S.E. Kurt       1.400
Skewness           .129              S.E. Skew        .717
Range             8.000              Minimum            0
Maximum               8              Sum           33.000

Valid Observations -        9        Missing Observations -        4

-----------------------------------------------------------------------------------
Page  55                          SPSS/PC+                                10/23/92

Number of Valid Observations (Listwise) =        7.00

Variable  SW_TOTAL

Mean             13.462              S.E. Mean       3.930
Std Dev          14.169              Variance      200.769
Kurtosis           .692              S.E. Kurt       1.191
Skewness          1.068              S.E. Skew        .616
Range            46.000              Minimum            0
Maximum              46              Sum          175.000

Valid Observations -       13        Missing Observations -        0
```

Figure 25. Sample SPSS descriptive statistics using CORMSAMP.DBF.

```
Page  56                          SPSS/PC+                        10/23/92

Number of Valid Observations (Listwise) =        7.00

Variable  TN_TOTAL

Mean           20.538          S.E. Mean       4.369
Std Dev        15.751          Variance      248.103
Kurtosis        -.632          S.E. Kurt       1.191
Skewness         .714          S.E. Skew        .616
Range          48.000          Minimum             2
Maximum            50          Sum           267.000

Valid Observations -      13       Missing Observations -      0
---------------------------------------------------------------------------
Page  57                          SPSS/PC+                        10/23/92

Number of Valid Observations (Listwise) =        7.00

Variable  COMMENTS

Statistics cannot be computed for this variable.
This is a String (Alphanumeric) variable.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

Variable  SAMPPROD

Mean            1.512          S.E. Mean        .124
Std Dev          .328          Variance         .107
Kurtosis        -.097          S.E. Kurt       1.587
Skewness        -.080          S.E. Skew        .794
Range           1.000          Minimum          1.00
Maximum          2.00          Sum            10.583

Valid Observations -       7       Missing Observations -      6
---------------------------------------------------------------------------
Page  58                          SPSS/PC+                        10/23/92

Number of Valid Observations (Listwise) =        7.00

Variable  COLYPROD

Mean            1.128          S.E. Mean        .130
Std Dev          .343          Variance         .118
Kurtosis         .800          S.E. Kurt       1.587
Skewness         .942          S.E. Skew        .794
Range           1.030          Minimum           .72
Maximum          1.75          Sum             7.896
```

Figure 26. Sample SPSS t-tests for Pelagic Cormorants on East and West Anacapa Islands.

```
Page  12                        SPSS/PC+                               2/20/92

This procedure was completed at 11:49:34
SELECT IF (SPECIES EQ 'PECO').
COMPUTE SAMPPROD=CHICKS/W_W_CKS.
COMPUTE COLYPROD=(SAMPPROD*W_W_INC+CHICKS)/W_TOTAL.
T-TEST GROUPS = ISLAND ('E_ANAC', 'W_ANAC')
The raw data or transformation pass is proceeding
      9 cases are written to the uncompressed active file.
/VARIABLES SAMPPROD COLYPROD.
-----------------------------------------------------------------------------
Page  13                        SPSS/PC+                               2/20/92

Independent samples of  ISLAND

Group 1:  ISLAND  EQ  E_ANAC         Group 2:  ISLAND  EQ  W_ANAC


t-test for:  SAMPPROD

                 Number               Standard   Standard
                of Cases     Mean    Deviation     Error

     Group 1        3       1.2407      .251        .145
     Group 2        6       1.8056      .371        .152


                | Pooled Variance Estimate | Separate Variance Estimate
                |                          |
   F    2-Tail  |   t    Degrees of 2-Tail |   t    Degrees of   2-Tail
 Value  Prob.   | Value   Freedom    Prob. | Value   Freedom     Prob.
                |                          |
  2.20   .683   | -2.34      7       .052  | -2.70     5.94       .036
-----------------------------------------------------------------------------
Page  14                        SPSS/PC+                               2/20/92

Independent samples of  ISLAND

Group 1:  ISLAND   EQ  E_ANAC         Group 2:  ISLAND   EQ  W_ANAC


t-test for:  COLYPROD

                 Number               Standard   Standard
                of Cases     Mean    Deviation     Error

     Group 1        3       1.1825      .276        .159
     Group 2        6       1.6508      .434        .177


                | Pooled Variance Estimate | Separate Variance Estimate
                |                          |
   F    2-Tail  |   t    Degrees of 2-Tail |   t    Degrees of   2-Tail
 Value  Prob.   | Value   Freedom    Prob. | Value   Freedom     Prob.
                |                          |
  2.47   .626   | -1.68      7       .138  | -1.97     6.21       .095
-----------------------------------------------------------------------------
Page  15                        SPSS/PC+                               2/20/92

This procedure was completed at 11:49:43
```

Figure 27. Sample printout of Western Gull summary data, WGSUM.DBF.

Record#	YEAR	ISLAND	GRID	WEST	CLCH_SIZ	CKS_HACH	MIN_FLEG	MAX_FLEG
1	90	SBI	A	01	2	2	0	1
2	90	SBI	A	02	2	1	0	0
3	90	SBI	A	03	3	3	1	1
4	90	SBI	A	04	1	0	0	0
5	90	SBI	A	05	1	1	0	1
6	90	SBI	A	06	3	2	2	2
7	90	SBI	A	07	3	1	0	0
8	90	SBI	A	08	2	0	0	0
9	90	SBI	A	09	2	2	0	2
10	90	SBI	A	10	3	3	0	2
11	90	SBI	A	11	2	2	0	0
12	90	SBI	A	12	2	2	0	2
13	90	SBI	A	13	2	1	0	1
14	90	SBI	A	14	3	0	0	0
15	90	SBI	A	15	3	1	0	0
16	90	SBI	A	16	2	1	0	1
17	90	SBI	A	17	2	2	2	2
18	90	SBI	A	18	1	1	1	1
19	90	SBI	A	19	2	2	0	2
20	90	SBI	A	20	3	0	0	0
21	90	SBI	A	21	3	3	3	3
22	90	SBI	A	22	2	0	0	0
23	90	SBI	A	23	3	3	0	1
24	90	SBI	A	24	3	2	0	0
25	90	SBI	A	25	2	2	1	2
26	90	SBI	A	26	1	0	0	0
27	90	SBI	A	27	2	2	1	2
28	20	SBI	A	28	1	0	0	0
29	90	SBI	A	29	2	2	2	2
30	90	SBI	D	01	3	3	2	2
31	90	SBI	D	02	3	2	2	2
32	90	SBI	D	03	3	3	2	3
33	90	SBI	D	04	2	2	1	1
34	90	SBI	D	05	3	0	0	0
35	90	SBI	D	06	3	2	2	2
36	90	SBI	D	07	1	1	1	1
37	90	SBI	D	08	1	0	0	0
38	90	SBI	D	09	2	2	2	2
39	90	SBI	D	10	1	0	0	0
40	90	SBI	D	11	3	3	2	3
41	90	SBI	D	12	3	2	0	0
42	90	SBI	D	13	2	2	2	2
43	90	SBI	D	14	3	1	1	1
44	90	SBI	D	15	1	1	0	1
45	90	SBI	D	16	2	2	2	2
46	90	SBI	D	17	2	0	0	0
47	90	SBI	D	18	2	2	1	2
48	90	SBI	D	19	2	2	0	2
49	90	SBI	D	20	1	0	0	0
50	90	SBI	D	21	2	0	0	0

Figure 28. Sample SPSS printout showing descriptive statistics for Western Gulls using WGSUM.DBF.

```
------------------------------------------------------------------------------
Page    2                          SPSS/PC+                          2/20/92

This procedure was completed at 13:36:08
COMPUTE HACHSUCC=CKS_HACH/CLCH_SIZ.
COMPUTE MINFSUCC=MIN_FLEG/CKS_HACH.
COMPUTE MAXFSUCC=MAX_FLEG/CKS_HACH.
COMPUTE FLEGSUCC=(MINFSUCC + MAXFSUCC)/2.
COMPUTE MINREPRO=MIN_FLEG/CLCH_SIZ.
COMPUTE MAXREPRO=MAX_FLEG/CLCH_SIZ.
COMPUTE REPROSUC=(MINREPRO + MAXREPRO)/2.
COMPUTE PRODUCT=(MIN_FLEG + MAX_FLEG)/2.
SELECT IF (ISLAND EQ 'SBI' AND GRID EQ 'A').
DESCRIPTIVES CLCH_SIZ TO PRODUCT/STATISTICS=ALL.
The raw data or transformation pass is proceeding
     29 cases are written to the uncompressed active file.

WARNING 11003
PAGE TOO NARROW TO PRINT COLUMNAR STYLE DESCRIPTIVE STATISTICS--Too many
statistics are requested to print them in columns.  Serial format is used.

------------------------------------------------------------------------------
Page    3                          SPSS/PC+                          2/20/92


Number of Valid Observations (Listwise) =        22.00

Variable  CLCH_SIZ

Mean             2.172              S.E. Mean         .132
Std Dev           .711              Variance          .505
Kurtosis         -.894              S.E. Kurt         .845
Skewness         -.263              S.E. Skew         .434
Range            2.000              Minimum              1
Maximum              3              Sum             63.000

Valid Observations -       29       Missing Observations -        0
------------------------------------------------------------------------------
Page    4                          SPSS/PC+                          2/20/92

Number of Valid Observations (Listwise) =        22.00

Variable  CKS_HACH

Mean             1.414              S.E. Mean         .189
Std Dev          1.018              Variance         1.037
Kurtosis        -1.095              S.E. Kurt         .845
Skewness         -.076              S.E. Skew         .434
Range            3.000              Minimum              0
Maximum              3              Sum             41.000

Valid Observations -       29       Missing Observations -        0
------------------------------------------------------------------------------
```

Figure 28. Sample SPSS printout showing descriptive statistics for Western Gulls using WGSUM.DBF.

Page 5 SPSS/PC+ 2/20/92

Number of Valid Observations (Listwise) = 22.00

Variable MIN_FLEG

Mean	.448	S.E. Mean	.154
Std Dev	.827	Variance	.685
Kurtosis	2.409	S.E. Kurt	.845
Skewness	1.801	S.E. Skew	.434
Range	3.000	Minimum	0
Maximum	3	Sum	13.000

Valid Observations - 29 Missing Observations - 0

Page 6 SPSS/PC+ 2/20/92

Number of Valid Observations (Listwise) = 22.00

Variable MAX_FLEG

Mean	.966	S.E. Mean	.175
Std Dev	.944	Variance	.892
Kurtosis	-1.242	S.E. Kurt	.845
Skewness	.346	S.E. Skew	.434
Range	3.000	Minimum	0
Maximum	3	Sum	28.000

Valid Observations - 29 Missing Observations - 0

Page 7 SPSS/PC+ 2/20/92

Number of Valid Observations (Listwise) = 22.00

Variable HACHSUCC

Mean	.638	S.E. Mean	.079
Std Dev	.425	Variance	.181
Kurtosis	-1.405	S.E. Kurt	.845
Skewness	-.584	S.E. Skew	.434
Range	1.000	Minimum	.00
Maximum	1.00	Sum	18.500

Valid Observations - 29 Missing Observations - 0

Figure 28. Sample SPSS printout showing descriptive statistics for Western Gulls using WGSUM.DBF.

```
Page   8                    SPSS/PC+                          2/20/92

Number of Valid Observations (Listwise) =       22.00

Variable  MINFSUCC

Mean              .288              S.E. Mean          .091
Std Dev           .425              Variance           .180
Kurtosis         -.780              S.E. Kurt          .953
Skewness         1.019              S.E. Skew          .491
Range            1.000              Minimum             .00
Maximum           1.00              Sum               6.333

Valid Observations -        22        Missing Observations -        7
---------------------------------------------------------------------------
Page   9                    SPSS/PC+                          2/20/92

Number of Valid Observations (Listwise) =       22.00

Variable  MAXFSUCC

Mean              .674              S.E. Mean          .092
Std Dev           .432              Variance           .186
Kurtosis        -1.279              S.E. Kurt          .953
Skewness         -.760              S.E. Skew          .491
Range            1.000              Minimum             .00
Maximum           1.00              Sum              14.833

Valid Observations -        22        Missing Observations -        7
---------------------------------------------------------------------------
Page  10                    SPSS/PC+                          2/20/92

Number of Valid Observations (Listwise) =       22.00


Variable  FLEGSUCC

Mean              .481              S.E. Mean          .078
Std Dev           .368              Variance           .136
Kurtosis        -1.223              S.E. Kurt          .953
Skewness          .138              S.E. Skew          .491
Range            1.000              Minimum             .00
Maximum           1.00              Sum              10.583

Valid Observations -        22        Missing Observations -        7
---------------------------------------------------------------------------
```

Figure 28. Sample SPSS printout showing descriptive statistics for Western Gulls using WGSUM.DBF.

```
Page  11                        SPSS/PC+                              2/20/92

Number of Valid Observations (Listwise) =      22.00

Variable  MINREPRO

Mean               .207            S.E. Mean        .069
Std Dev            .369            Variance         .136
Kurtosis           .659            S.E. Kurt        .845
Skewness          1.495            S.E. Skew        .434
Range             1.000            Minimum           .00
Maximum            1.00            Sum             6.000

Valid Observations -      29      Missing Observations -      0
------------------------------------------------------------------------------
Page  12                        SPSS/PC+                              2/20/92

Number of Valid Observations (Listwise) =      22.00

Variable  MAXREPRO

Mean               .466            S.E. Mean        .083
Std Dev            .446            Variance         .199
Kurtosis         -1.807            S.E. Kurt        .845
Skewness           .142            S.E. Skew        .434
Range             1.000            Minimum           .00
Maximum            1.00            Sum            13.500

Valid Observations -      29      Missing Observations -      0
------------------------------------------------------------------------------
Page  13                        SPSS/PC+                              2/20/92

Number of Valid Observations (Listwise) =      22.00

Variable  REPROSUC

Mean               .336            S.E. Mean        .068
Std Dev            .365            Variance         .133
Kurtosis          -.844            S.E. Kurt        .845
Skewness           .712            S.E. Skew        .434
Range             1.000            Minimum           .00
Maximum            1.00            Sum             9.750

Valid Observations -      29      Missing Observations -      0
------------------------------------------------------------------------------
Page  14                        SPSS/PC+                              2/20/92

Number of Valid Observations (Listwise) =      22.00

Variable  PRODUCT

Mean               .707            S.E. Mean        .150
Std Dev            .808            Variance         .652
Kurtosis           .801            S.E. Kurt        .845
```

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APPENDICES

Appendix A. Reproduction in Double-Crested Cormorants on West Anacapa and Santa Barbara Islands, 1969-1990.

Island	Year	Nests	Young	Productivity
[1]West Anacapa	1969	76	0	0
	1970	50	3	0.06
	1971	48	0	0
	1972	26	9	0.35
	1973	16	3	0.19
	1974	29	1	0.03
	1975	3	3	1.00
	1976	7	2	0.29
	1977	15	18	1.20
	1978	34	49	1.44
	1979	66	38	0.58
	1980	84	36	0.46
	1981	79	77	0.97
	1982	118	145	1.23
	1983	96	74	0.77
	1984	61	117	1.92
	1985	102	250	2.45
	1986	86	141	1.64
	1987	183	297	1.62
	1988	160	373	2.33
	1989	ND		
	1990	340	512	1.51
[2]Santa Barbara	1976	42	96	2.29
	1977	67	63	0.94
	1985	60	120	2.00
	1986	64	107	1.68
	1987	171	271	1.58
	1988	162	297	1.83
	1989	ND		
	1990	267	301	1.13

[1]Data for years 1969-72 from Gress et al. 1973; for 1973-80, Anderson and Gress 1983; for 1981, 1983-84, 1987-88, F. Gress, unpubl. data; for 1982, Gress and Anderson 1982; for 1985-86, Lewis and Gress 1988.

[2]Data for years 1976-77 from Hunt et al. 1979; for 1985-86, Lewis and Gress 1988; for 1987-88, NPS unpubl. data.

Appendix B. Clutch Initiation in Brown Pelicans on West Anacapa Island, 1970-1990.

Year	Months	Source
1970	M-Mar--L-Jun	Data for 1970-1980: after Anderson and Gress, 1983
1971	E-Apr--M-Jul	
1972	E-May--E-Aug	
1973	M-Apr--M-Jul	
1974	M-Mar--E-Jul	
1975	E-May--L-Jul	
1976	E-Mar--M-Jun	
1977	M-Mar--M-May	
1978	M-Mar--L-Jun	
1979	E-Jan--M-Jun	
1980	M-Jan--E-Jul	
1981	L-Dec--M-Jun	Gress, F. 1982
1982	E-Feb--L-May	Gress, et al. 1983
1983	M-Feb--M-Apr	Gress and Anderson 1984
1984	L-Mar--L-Jun	Gress and Anderson 1985
1985	E-Jan--L-Jul	Lewis and Gress, unp. ms
1986	L-Dec--M-Jun	Lewis and Gress 1988
1987	L-Jan--L-May	Gress and Lewis 1988
1988	M-Feb--M-Jul	Data for 1988-1989: Gress et al. 1990
1989	L-Dec--M-Jun	

E=Early, days 1-10
M=Middle, days 11=20
L=Late, days 21-31

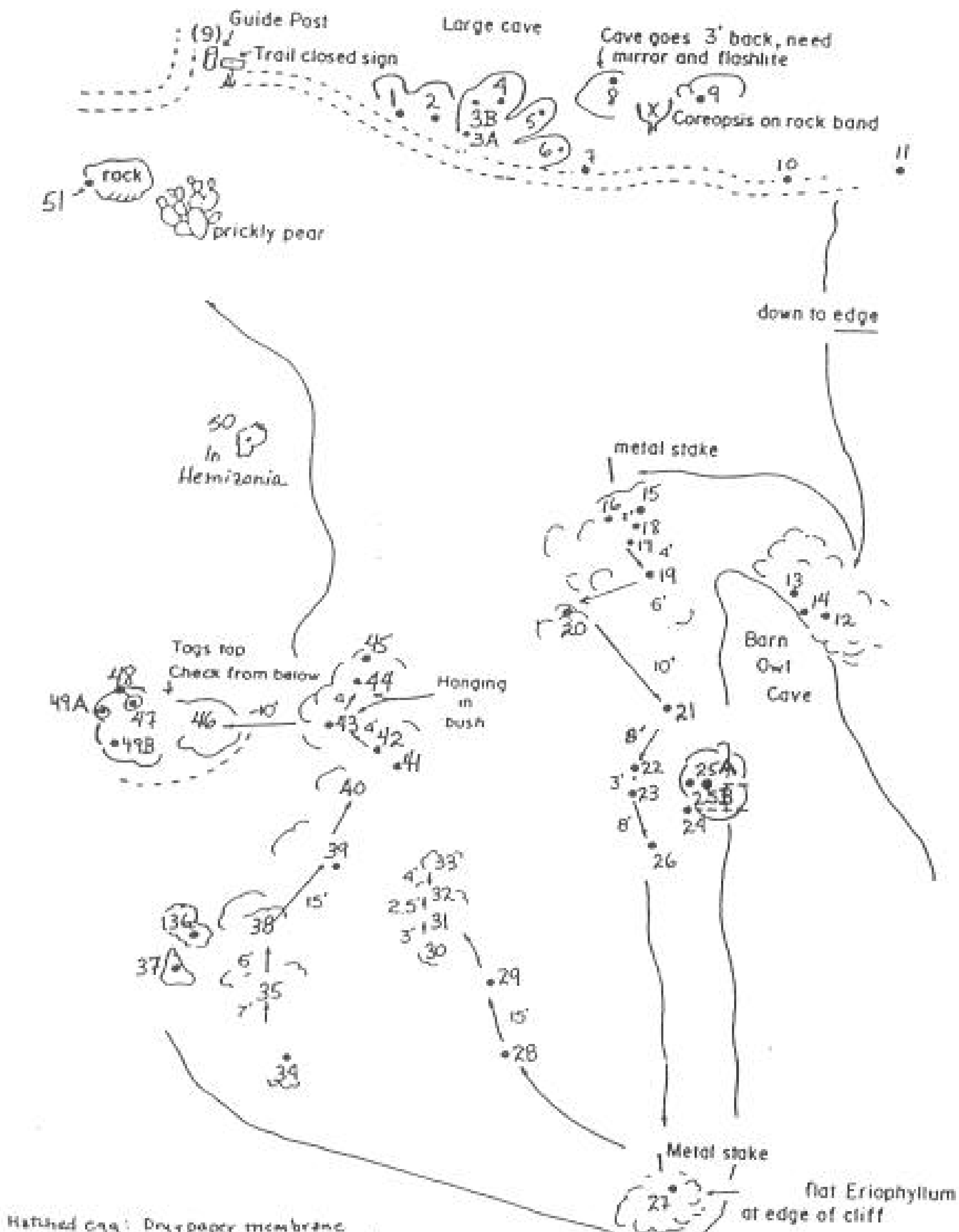
Appendix C. Reproduction in California Brown Pelicans in Channel Islands National Park, 1969-1990.

Island	Year	Nests	Fledglings	Productivity
[1]West Anacapa	1969	750	4	0.005
	1970	552	1	0.002
	1971	540	7	0.013
	1972	261	57	0.22
	1973	247	34	0.14
	1974	416	305	0.73
	1975	292	256	0.88
	1976	417	279	0.67
	1977	76	39	0.51
	1978	210	37	0.18
	1979	1258	980	0.78
	1980	2147	1438	0.67
	1981	2946	1805	0.61
	1982	1862	1175	0.63
	1983	1856	1149	0.62
	1984	628	530	0.84
	1985	5148	6387	1.24
	1986	5958	3986	0.67
	1987	6326	4257	0.67
	1988	2721	2465	0.91
	1989	4986	2877	0.58
	1990	2175	650	0.30
[2]Santa Barbara	1980	97	77	0.79
	1981	0		
	1982	0		
	1983	21	10	0.48
	1984	0		
	1985	1046	1515	1.45
	1986	1441	615	0.43
	1987	841	641	0.76
	1988	157	35	0.22
	1989	973	623	0.64
	1990	225	3	0.013

[1]Data for years 1969-1974 from Anderson et al. 1975; for 1975-1980, Anderson and Gress 1983; for 1981, Gress 1982; for 1982, Gress et al. 1983; for 1983, Gress and Anderson 1984; for 1984, Gress and Anderson 1985; for 1985-1986, Lewis and Gress 1988; for 1987, Gress and Lewis 1988; for 1988-1989, Gress et al. 1990.

[2]Data for 1980 from Gress 1981, Gress and Anderson 1983; for 1983, Gress and Anderson 1984; for 1985-1986, Lewis and Gress 1988; for 1987, Gress and Lewis 1988; for 1988-1989, Gress et al. 1990.

Appendix D. Burrow locations for Xantus' Murrelets at Nature Trail, Santa Barbara Island.



Hatched egg: Dry + paper membrane
Bloody, vascularized membrane

Mouse-eaten (broken): Dirt-encrusted
Shiny adherent membrane
Tooth marks

Appendix E. Burrow locations for Xantus' Murrelets at Cat Canyon, Santa Barbara Island.